EXHIBIT 11

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

ASETEK DANMARK A/S, Plaintiff and Counter-Defendant, v. COOLIT SYSTEMS, INC., Defendant and Counterclaimant.	CASE NO. 3:19-CV-00410-EMC **Highly Confidential – Attorneys' Eyes Only**

EXPERT REPORT OF HIMANSHU POKHARNA, PH.D. IN RESPONSE TO DR. TUCKERMAN'S REPORT ON INVALIDITY OF US PATENT NOS. 8,746,330; 9,603,284; AND 10,274,266

HimPokha

Himanshu Pokharna, Ph.D.

December 8, 2021

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HIGHLY CONFIDENTIAL – ATTORNEYS' EYES ONLY

I. INTRODUCTION

1. My name is Himanshu Pokharna, Ph.D., and I have been retained by CoolIT Systems, Inc. as an expert in *Asetek Danmark A/S v. CoolIT Systems, Inc. et al.*, Case No. 3:19-cv-00410-EMC pending in the United States District Court for the Northern District of California to opine on issues related to the validity of certain claims of U.S. Patent Nos. 8,746,330 ("the '330 patent"), 9,603,284 ("the '284 patent") and 10,274,266 ("the '266 patent") (together "the CoolIT Asserted Patents").

2. Specifically, I have been asked to analyze Dr. Tuckerman's opinions in his opening invalidity report related to the CoolIT Asserted Patents. I have prepared this report to detail and memorialize my findings and opinions and the bases for my findings and opinions. I reserve the right to supplement or modify my opinions and the bases for my opinions based on evidence or testimony that Asetek or its experts, or any other witnesses, may present and/or based on any additional discovery Asetek may produce.

A. Qualifications and Experience

3. I am an engineer with 25 years of global experience in a variety of leadership roles. My educational, research and work experience has revolved primarily around energy, materials, and thermal technologies. I have expertise in creating product

strategy by mapping technology competencies to emerging market opportunities. My background allows me to be comfortable in the deepest of technical discussions with engineers to broad, board-level business deliberations. I have a proven track record of successfully introducing new energy/mechanical/thermal technologies across a broad array of computing, energy and military / aerospace products. I am experienced in building and leading teams of engineers, technicians and business people across geographies.

4. I am currently the Founder and Director of Deep Materials Inc., a company devoted to developing thermal management components such as thermal interface materials and heat sinks for computing and consumer electronic systems. In addition, I serve as a founder and board member of Inficold which is developing thermal energy storage systems for refrigeration and air-conditioning equipment with emphasis on cold storage and milk cooling. I also have other interests including being a principal of Deeia Inc., a consulting business providing thermal design support to clients such as Google, Facebook, and startups for thermal design of consumer electronics and computing devices.

5. I received a Bachelor's of Technology and a Master's of Technology (equivalent to a B.S. and an M.S. in the United States, respectively) in mechanical engineering from the Indian Institute of Technology, Bombay. I also earned a Ph.D.

in Nuclear Energy Engineering from Purdue University in 1997. My Ph.D. thesis focused on modeling of two-phase flow dynamics in heat transfer systems and specifically developed analytical models for the simultaneous flows of water and water vapor in a system during heat absorption. Examples of such systems are boiling water reactors. In addition, I have an MBA degree from the Wharton School at the University of Pennsylvania.

6. I have worked in various capacities in the electronics industry since 1997. My experience includes leading a team of over 25 engineers at Intel Corporation in the development of thermal management technology for laptop computers. My areas of expertise include thermal management of electronics and energy systems. I have published more than 15 peer-reviewed scientific articles and have made many presentations at scientific and industrial conferences, including several keynote addresses at industry forums such as the Taiwan Thermal Management Association ("TTMA") annual meetings, with the primary emphasis being heat-pipe development. I have over sixty issued or pending patents.

7. Prior to my team management responsibility at Intel, I specifically worked on liquid cooling of computing systems and demonstrated one of the first two-phase liquid cooling pumped loop coolers in a thin and light laptop computer. This work

resulted in a keynote address to the Second International Conference on Microchannel and Minichannels held in Rochester, NY (June 17-19, 2004).

8. A copy of my Curriculum Vitae ("CV"), which describes my education, training, and experience in greater detail, is appended as **Appendix I**. My CV includes a list of publications I have authored, as well as a list of the patents on which I am a named inventor.

9. I am being compensated for the time I spend working on this matter at my standard rate of $400 per hour. My compensation does not depend in any way upon the outcome of this proceeding, and I hold no financial interest in either CoolIT Systems, Inc. ("CoolIT"), Corsair Gaming, Inc., Corsair Memory, Inc., or Asetek A/S Danmark ("Asetek").

B. Materials Considered and Basis for Opinions

10. In forming my opinions, I have relied on my own background, knowledge, and experience relating to the subject matter of the CoolIT Asserted Patents. I have further considered the materials identified in the body of this report, the accompanying Exhibits attached hereto, and those identified in **Appendix II**, some of which may also be cited in the body of this report and the Exhibits.

II. APPLICABLE LAW

11. I am not a legal expert or an attorney, and I am not offering any opinions on the law. While I am not an attorney, I understand that in providing my opinions there are certain principles of patent law that I should apply.

A. Presumption of Validity

12. I understand that patents (*e.g.*, the '330, '284, and '266 patents) that have been issued by the U.S. Patent and Trademark Office ("USPTO") are presumed to be valid, and a party challenging the validity of claims of an issued U.S. patent bears the burden of proving invalidity by clear and convincing evidence.

B. Claim Construction

13. I am informed and understand that claim terms must be properly construed prior to assessing patentability. I also understand that the words of a claim are generally given their ordinary and customary meaning, which is the meaning the words would have to a person of ordinary skill in the art at the time of the invention. However, I also understand that the claims do not stand alone and that the customary meaning should be harmonized, to the extent possible, with the patent specification and the prosecution history of the patent. I also understand that extrinsic sources, like dictionaries, handbooks, textbooks, etc., can "shed useful light" on the proper construction of a claim term.

C. Anticipation Under 35 U.S.C. § 102

14. I understand that Dr. Tuckerman asserts that certain prior art references show the invalidity of some of the asserted claims by anticipation under § 102 of the patent laws. I understand that a patent claim is anticipated if, as of the critical date (*i.e.*, either the earliest claimed priority date (pre-AIA) or the effective filing date (AIA)), each and every limitation recited in the claim is found either expressly or inherently in a single prior art reference and arranged in the prior art in the same way as it is claimed, such that the disclosure effectively puts the public in possession of the invention. Finally, I understand that for a prior art reference to inherently disclose a claim limitation, that claim limitation must necessarily be present in the prior art reference.

D. Obviousness Under 35 U.S.C. § 103

15. I understand that Dr. Tuckerman also asserts that the challenged claims are obvious in view of certain prior art references under section 103 of the patent laws. I understand that a patent claim is obvious if, as of the critical date (*i.e.*, either the earliest claimed priority date (pre-AIA) or the effective filing date (AIA)), it would have been obvious to a person having ordinary skill in the field of the technology (the "art") to which the claimed subject matter belongs.

16. I understand that the following factors should be considered in analyzing obviousness: (1) the scope and content of the prior art; (2) the differences between the prior art and the claims; and (3) the level of ordinary skill in the pertinent art. I also understand that certain other facts known as "secondary considerations" such as commercial success, unexplained results, long felt but unsolved need, industry acclaim, simultaneous invention, copying by others, skepticism by experts in the field, and failure of others may be utilized as indicia of nonobviousness. I understand, however, that secondary considerations should be connected, or have a "nexus," with the invention claimed in the patent at issue.

17. I understand that a reference qualifies as prior art for obviousness purposes when it is analogous to the claimed invention. The test for determining what art is analogous is: (1) whether the art is from the same field of endeavor, regardless of the problem addressed, and (2) if the reference is not within the field of the inventor's endeavor, whether the reference still is reasonably pertinent to the particular problem with which the inventor is involved.

18. I understand that a person of ordinary skill in the art is assumed to have knowledge of all prior art. I understand that one skilled in the art can combine various prior art references based on the teachings of those prior art references, the general knowledge present in the art, or common sense. I understand that a

motivation to combine references may be implicit in the prior art, and there is no requirement that there be an actual or explicit teaching to combine two references. Thus, one may take into account the inferences and creative steps that a person of ordinary skill in the art would employ to combine the known elements in the prior art in the manner claimed by the patent at issue. I understand that one should avoid "hindsight bias" and *ex post* reasoning in performing an obviousness analysis. But this does not mean that a person of ordinary skill in the art for purposes of the obviousness inquiry does not have recourse to common sense.

19. I understand that when determining whether a patent claim is obvious in light of the prior art, neither the particular motivation for the patent nor the stated purpose of the patentee is controlling. The primary inquiry has to do with the objective reach of the claims, and that if those claims extend to something that is obvious, then the entire patent claim is invalid.

20. I understand that one way that a patent can be obvious is if there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent's claims. I understand that a motivation to combine various prior art references to solve a particular problem may come from a variety of sources, including market demand or scientific literature. I understand that a need or problem known in the field at the time of the invention can also provide a reason

to combine prior art references and render a patent claim invalid for obviousness. I understand that familiar items may have obvious uses beyond their primary purpose, and that a person of ordinary skill in the art will be able to fit the teachings of multiple prior art references together like the pieces of a puzzle. I understand that a person of ordinary skill is also a person of at least ordinary creativity. I understand that when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. If this finite number of predictable solutions leads to the anticipated success, I understand that the invention is likely the product of ordinary skill and common sense, and not of any sort of innovation. I understand that the fact that a combination was obvious to try might also show that it was obvious, and hence invalid, under the patent laws. I understand that if a patent claims a combination of familiar elements according to known methods, the combination is likely to be obvious when it does not more than yield predictable results. Thus, if a person of ordinary skill in the art can implement a predictable variation, an invention is likely obvious. I understand that combining embodiments disclosed near each other in a prior art reference would not ordinarily require a leap of inventiveness.

21. I understand that obviousness may be shown by demonstrating that it would have been obvious to modify what is taught in a single piece of prior art to create the patented invention. Obviousness may also be shown by demonstrating that it would have been obvious to combine the teachings of more than one item of prior art. I understand that a claimed invention may be obvious if some teaching, suggestion, or motivation exists that would have led a person of ordinary skill in the art to combine the invalidating references. I also understand that this suggestion or motivation may come from the knowledge of a person having ordinary skill in the art, or from sources such as explicit statements in the prior art. I understand that when there is a design need or market pressure, and there are a finite number of predictable solutions, a person of ordinary skill may be motivated to apply common sense and his or her skill to combine the known options in order to solve the problem.

22. I understand the following are examples of approaches and rationales that may be considered in determining whether a piece of prior art could have been combined with other prior art or with other information within the knowledge of a person having ordinary skill in the art:

(1) Some teaching, motivation, or suggestion in the prior art that would have led a person of ordinary skill to modify the prior art reference or

to combine prior art reference teachings to arrive at the claimed invention;

(2) Known work in one field of endeavor may prompt variations of it for use in the same field or a different field based on design incentives or other market forces if the variations would have been predictable to a person of ordinary skill in the art;

(3) Combining prior art elements according to known methods to yield predictable results;

(4) Applying a known technique to a known device, method, or product ready for improvement to yield predictable results;

(5) Applying a technique or approach that would have been "obvious to try" (choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success);

(6) Simple substitution of one known element for another to obtain predictable results; or

(7) Use of a known technique to improve similar products, devices, or methods in the same way.

23. I understand that, when determining whether a claimed combination is obvious, the correct analysis is not whether one of ordinary skill in the art, writing

on a blank slate, would have chosen the particular combination of elements described in the claim. Instead, I understand that the correct analysis considers whether one of ordinary skill, facing the wide range of needs created by developments in the field of endeavor, would have seen a benefit to selecting the combination claimed.

24. I understand that the test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference. The test for obviousness, in other words, is not whether the references could be physically combined but whether the claimed inventions are rendered obvious by the teachings of the prior art as a whole.

E. Definiteness, Written Description Support Under 35 U.S.C. § 112

25. I understand that Dr. Tuckerman asserts that certain claims of the '284 patent are invalid for lack of written description support and/or indefiniteness under section 112 of the patent laws. I understand that a patent claim must contain an adequate written description of the claimed invention. I understand that the written description of the patent must convey to a person of skill in the art that the inventors were in possession of the invention as of the patent application filing date, even though the claims may have been changed or new claims may have been added since that time. I also understand that the written description requirement is satisfied if a

person of ordinary skill in the art reading the patent application at the time it was filed would have recognized that the patent application described the invention as claimed, even though the description may not use the exact words found in the claim. The written description requirement may be satisfied by the patentee's disclosure of such descriptive means—*e.g.*, words, structures, figures, diagrams, tables—that fully set forth the claimed invention. I also understand that working examples are not necessary to satisfy the written description requirement. A requirement in a claim need not be specifically disclosed in the patent application as originally filed if a person of ordinary skill in the art would understand that the missing requirement is necessarily implied in the patent application as originally filed. I also understand that the patent does not need to disclose what is well known in the art to provide a sufficient written description. I understand that the party alleging invalidity must establish lack of written description by clear and convincing evidence.

26. I also understand that the written description set forth in a patent must disclose sufficient information to enable or teach a person of ordinary skill in the art how to make and use the full scope of the claimed invention. This requirement is known as the enablement requirement. A patent is enabling if its disclosure is sufficient to enable a person of ordinary skill in the art to make and use the claimed invention without undue experimentation. In considering whether the written description of a

patent satisfies the enablement requirement, the specification is viewed from the perspective of a person of ordinary skill in the art. I also understand that the patent need not teach, and preferably omits, what is well known in the art. Thus, a patent need not expressly state information that skilled persons would be likely to know or could obtain. I understand that to determine whether an "undue" level of experimentation is required to practice the invention, several factors—known as the *Wands* factors—are often considered in the analysis: (1) the quantity of experimentation necessary; (2) the amount of direction or guidance disclosed in the patent; (3) the presence or absence of working examples in the patent; (4) the nature of the invention; (5) the state of the prior art; (6) the relative skill of those in the art; (7) the predictability of the art; and (8) the breadth of the claims.

27. I understand that a patent claim is invalid for indefiniteness only if its claims, read in light of the specification and the prosecution history, fail to inform, with reasonable certainty, a person of ordinary skill in the art about the scope of the invention. The certainty which the law requires in patents is not greater than is reasonable having regard to the subject matter.

III. CLAIM CONSTRUCTION

28. I understand that the Court has conducted two claim construction proceedings in this case and that I submitted a declaration in support of CoolIT's proposed claim

constructions. The Court issued two claim construction orders, one on July 22, 2020, and a supplemental claim construction order on July 8, 2021. I have been provided with the Court's orders and opinions regarding claim construction. While I did not agree with all of the Court's constructions, I understand that in assessing the scope of the asserted claims for the CoolIT Asserted Patents, I am to apply the Court's constructions, summarized below:

a) "**microchannels**": "channels with width up to 1 millimeter";

b) "**fluid heat exchanger**": "component that transfers heat from a heat source to a cooling liquid circulated by a pump that is external to the component";

c) "**inlet header**": "a space out from which the liquid to be distributed flows";

d) "**outlet header**": "a space into which the collected liquid flows";

e) "**inlet manifold**": "a space out from which the liquid to be distributed flows";

f) "**exhaust manifold**": "a space into which the collected liquid flows";

g) "**adjacent**" and "**juxtaposed with**": "with no intervening solid structure between it and";

h) "**inlet**," "**inlet opening**," and "**aperture**": plain and ordinary meaning;

i) "**outlet opening**": plain and ordinary meaning;

j) "**at least partially**": plain and ordinary meaning;

k) "**inlet/outlet flow path**": plain and ordinary meaning;

l) "**seal**": "a component that fills a gap to prevent leakage through the gap";

m) "**first/second side of the [plurality of] fins**" and "**first/second side of the plurality of juxtaposed fins**": plain and ordinary meaning.

(*See generally* Dkt. Nos. 149, 258.)

29. If the Court were to issue a new or supplemental order regarding claim construction, I understand that those constructions would apply as a matter of law. I reserve the right to supplement and/or amend my analysis and opinions in this report in response to any such new or supplemental claim construction order. For all other claim terms, I have interpreted them from the perspective of a person of ordinary skill in the art (whose background, experience, and qualifications I have discussed below).

IV. PERSON OF ORDINARY SKILL IN THE ART

30. I understand that an assessment of claims of the CoolIT Asserted Patents should be undertaken from the perspective of a person of ordinary skill in the art

("POSITA") as of the earliest claimed priority date for the claimed subject matter, which I have assumed to be August 9, 2007.[1]

31. In my opinion, a POSITA in the context of the CoolIT Asserted Patents (around 2007) would have earned at least a bachelor's degree, such as a B.S. (Bachelor of Science), or equivalent thereof, in mechanical engineering or a closely-related field and possessed at least three years of specialized experience in heat transfer devices for thermal management in electronics and computer systems, or in similar systems.

32. Although my qualifications and experience exceed those of the POSITA defined above, the analysis and opinions I have provided in his Declaration are based on the perspective of a POSITA in the art as of August 9, 2007.[2]

V. BRIEF TECHNOLOGY BACKGROUND

33. Electronic components such as microprocessors, graphics processors, and power electronics semiconductor devices produce increasing amounts of heat during

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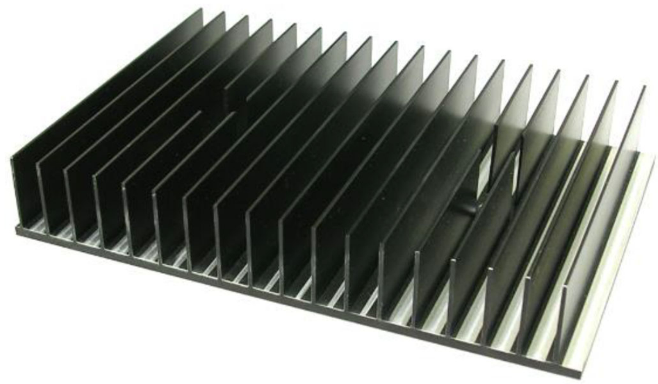
[1] The date of August 9, 2007 corresponds to the filing date of the 2007 Provisional and earliest-filed application on the face of the CoolIT Asserted Patents.

[2] My opinions expressed herein would not change if they were based on the perspective of a POSITA in the art as of July 27, 2011.

their operations. If the heat is not removed at a sufficient rate, component temperatures can exceed specified limits, resulting in reduced performance, decreased reliability, and, in some cases, damage or even outright failure of components or systems.



34. The industry has responded to this challenge with a number of techniques for transferring and dissipating heat from electronic components to another medium. Conventional air cooling uses a fan mounted on or adjacent to a heat producing component to draw hot air away from the electronic component and replace it with cooler ambient air.

35. Such conventional air cooling can be supplemented with a conventional air-cooled "heat sink," e.g., often a plate of a thermally conductive material (such as aluminum or copper) in thermal contact with a heat-producing device such as a microprocessor. The thermally conductive material can spread heat from the electronic component to a larger, area for dissipation to the surrounding air (or other fluid). Some heat sinks include "fins" (as shown on the right) to increase the area available for heat transfer and thereby to improve the transfer of heat to the air (or

other fluid passing over the fins). The thermal conductivity value of the plate of thermally conductive material is critical to spread the heat efficiently over a large area on which fins can be utilized. Electronic devices such as computers often combine fans and heat sinks to cool critical components.

36. Although increasing the size of the heat sink and altering the airflow can improve the heat sink performance, it is inherently limited by many physical constraints such as the thermal conductivity of the materials used, air flow rate, and acoustic considerations.

37. One way to improve the cooling of the semiconductor chips used in computing or other electronic systems is to utilize liquid cooling. Liquids such as water (and mixtures of water and glycol-based additives) have significantly better heat transfer capabilities than air. In its most basic form, the purpose of a liquid cooling system is to (a) remove heat efficiently from the chip, (b) transport heat from a device to a remote heat exchanger and (c) use large area of heat exchanger to efficiently reject the heat to another medium, e.g., air using a fan-based radiator or to another liquid (*e.g.*, facility water) using a liquid-to-liquid heat exchanger.

38. The liquid cooling system helps to reduce the thermal spreading resistance associated with the movement of heat from a small component to a larger surface. Microchannel heat exchangers provide a particularly efficient means of transferring

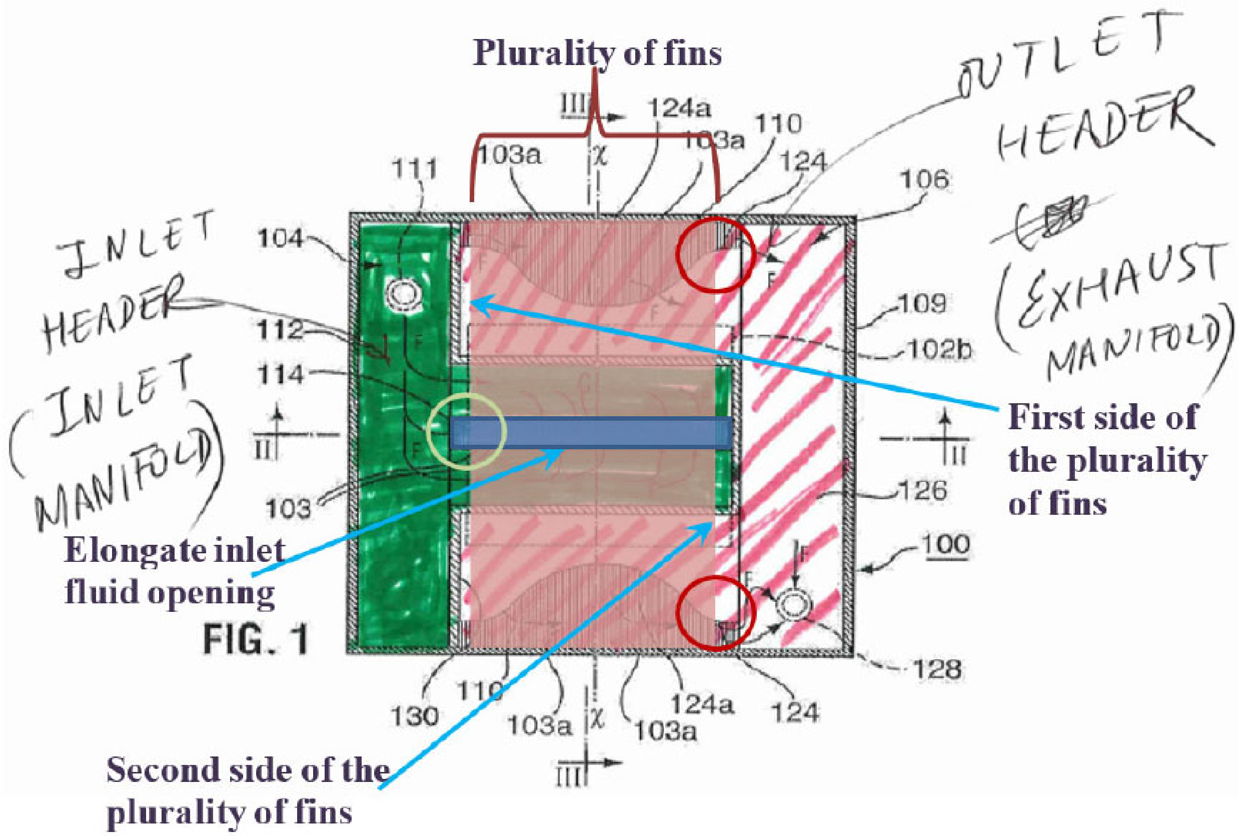
heat from the metal, in thermal contact with the heat producing component, to the cooling liquid.

VI. OVERVIEW OF THE COOLIT ASSERTED PATENTS

39. The CoolIT Asserted Patents are directed to systems for facilitating heat exchange between a heat generating component, *e.g.*, a CPU and liquid cooling system. Features of the CoolIT Asserted Patents are shown below in an annotated drawing of Figure 1 from the '330 patent,[3] which the Court relied on in rendering part of its claim construction orders and Figure 2 from the '330 patent[4]:

[3] The same unannotated drawing appears as Figure 1 in the '284 patent and a nearly identical version as Figure 2 in the'266 patent.

[4] The same figure appears as Figure 2 in the '284 patent and Figure 3 in the '266 patent.



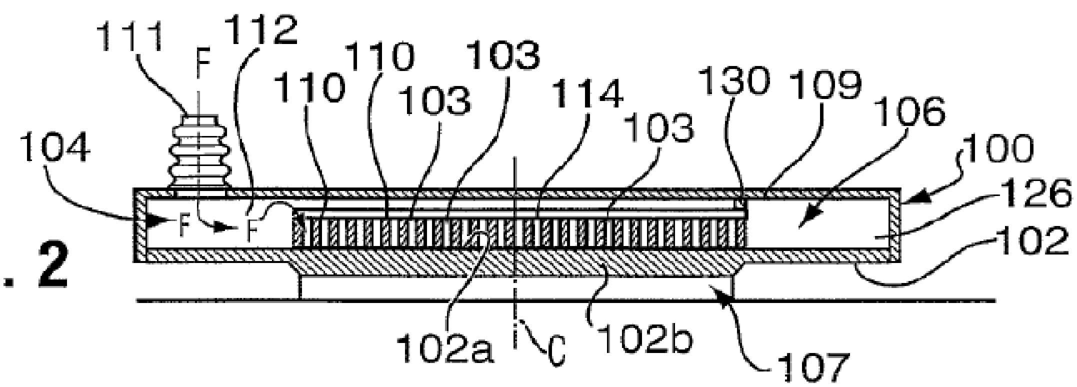


FIG. 2

40. As shown in the above figures, there is a heat spreader plate **102** that is in contact with a heat generating component **107** (*e.g.*, a CPU or GPU). The heat spreader plate has microchannels **103** (formed by a plurality of fins) which are

designed to allow liquid to flow through them thus increasing the conductive surface area. The CoolIT Asserted Patents further describe a system where the fluid is directed to flow into the center of the heat spreader plate and the flow is split going in opposite directions to the ends of the microchannels where the liquid is further directed out through the outlet header.

41. In addition, the patented claims in the '330 patent, '266 patent, and '284 patent recite combinations of many features that, taken together, define commercially viable cooling devices that incorporate a bifurcated flow of coolant.

42. As just one example, independent claim 1 in the '330 patent recites a fluid heat exchanger comprising a heat spreader plate that defines an upper surface. A plurality of fins extends from respective proximal ends positioned adjacent the upper surface of the heat spreader plate to respective distal ends positioned distally from the upper surface of the heat transfer plate. The plurality of fins defines a corresponding plurality of microchannels configured to direct a heat transfer fluid over the heat spreader plate. Each microchannel in the plurality of microchannels has a first end and an opposite end. Further, each microchannel in the plurality of microchannels extends substantially parallel with each of the other microchannels in the plurality of microchannels and has a continuous channel flow path between its respective first end and its respective opposite end. A plate is positioned over the

distal ends of the plurality of fins and the corresponding plurality of microchannels to close off the plurality of microchannels adjacent the distal ends of the plurality of fins. The plate positioned over the plurality of distal fin ends defines an elongate fluid inlet opening overlying and extending transversely relative to the plurality of microchannels between the plurality of microchannel first ends and opposite ends. The plate is so positioned over the plurality of fins as to define a first fluid outlet opening from each microchannel in the plurality of microchannels at each of the microchannel first ends and an opposite fluid outlet opening from each microchannel in the plurality of microchannels at each of the microchannel opposite ends. The fluid heat exchanger also includes a housing spaced from the plate positioned over the plurality of distal fin ends. The housing defines an inlet and an outlet. The inlet defined by the housing opens to an inlet header. And at least the first fluid outlet opening from each microchannel in the plurality of microchannels opens to an outlet header. The outlet defined by the housing opens from the outlet header. A seal extends between the housing and the plate positioned over the plurality of distal fin ends. The elongate fluid inlet opening defined by the plate extends between a proximal end and a distal end. A region of the inlet header is positioned adjacent a first side of the fins and a region of the outlet header is positioned adjacent the second side of the fins. Further, the fins, the plate, the housing, and the seal are arranged

such that the heat transfer fluid is directed from the inlet opening to the inlet header, through the elongate fluid inlet opening defined by the plate and into the microchannels, from the microchannels to the outlet header, and from the outlet header to the outlet defined by the housing.

43. In Section VII of his report, Dr. Tuckerman takes the position that "the core concept of the alleged invention of the asserted CoolIT patents was well known." Dr. Tuckerman states:

> The crux of CoolIT's disclosed and claimed fluid heat exchanger is an arrangement that allows the coolant to enter the microchannels at about midway along their length, such that the flow of coolant splits into two sub-flows that proceed in opposite directions towards the end of the microchannels. Such a flow arrangement is known in the field of liquid cooling as split-flow. But such split-flow arrangements in microchannels were routinely used before CoolIT filed its patents.

(Tuckerman Op. Rep., ¶39.) I disagree with Dr. Tuckerman's opinion.

44. First, Dr. Tuckerman oversimplifies the specific claimed designs in CoolIT's patents, which include specific combinations of features that resulted in superior liquid cooling devices. This is further demonstrated by the commercial success of CoolIT's products, as well as other indicators of nonobviousness, that I discuss in Section XI, below.

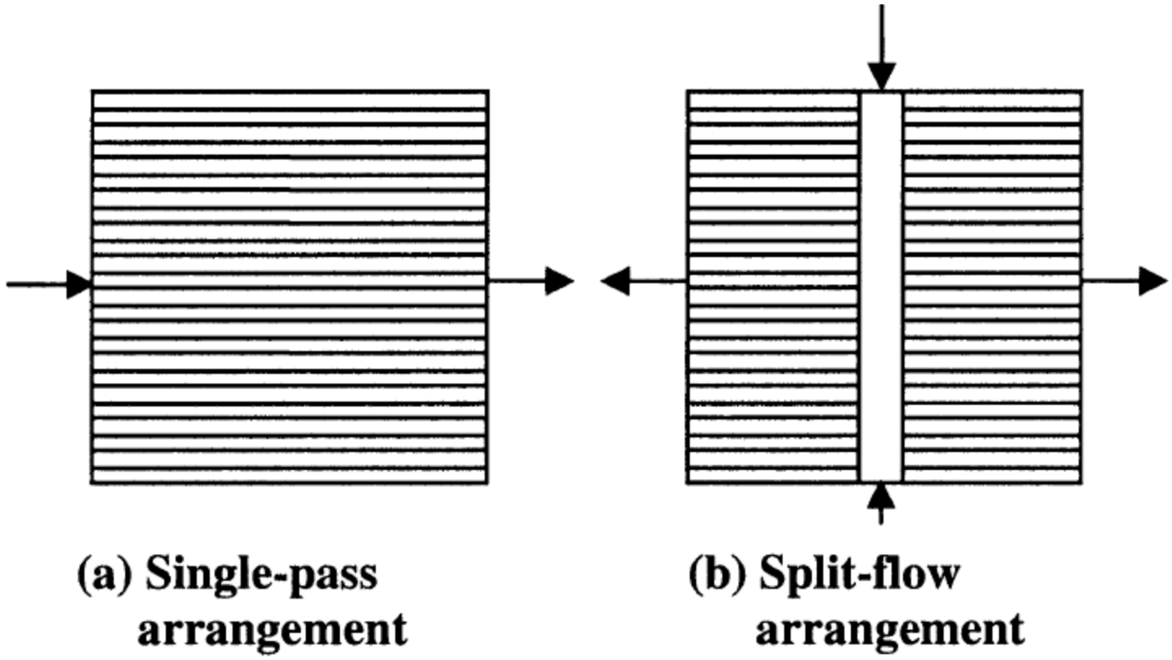
45. Second, none of the references that Dr. Tuckerman points to in Section VII of his report demonstrate the use of a separate fluid heat exchanger from the chip to be

cooled that bifurcates fluid flow into two sub-flows over the lengths of microchannels, where the two sub-flows recombine before exiting the fluid heat exchanger.

46. Dr. Tuckerman's thesis involved a design with multiple inlet and outlets, and, as admitted by Dr. Tuckerman, involved "scaling down the microchannel length, which can be achieved by having multiple coolant inlet and outlet points along the cold plate . . . , and thereby creating multiple split-flows throughout the length of the cold plate." (Tuckerman Op. Rep., ¶43.) Further, Dr. Tuckerman's thesis discusses microchannels in silicon chips having different materials properties and corresponding methods of manufacturing, and not a separate fluid heat exchanger from the chip.

47. *Kandlikar*, cited during prosecution of the '284 and '266 patents, does not disclose bifurcating fluid flow into two sub-flows over the lengths of microchannels. Dr. Tuckerman identifies Figure 7(b) of Kandlikar. Figure 7(b) does not disclose continuous microchannels, but rather two sets of microchannels separated by a much larger perpendicular channel where fluid enters. Notably, despite the position

Asetek advances regarding *Kandlikar*, Asetek appears to also argue that the concept in Figure 7(b) is a design around to CoolIT's patents.[5]



(Kandlikar, Figure 7(b).)

48. Dr. Tuckerman also identifies Figure 2 of *Kandlikar*, but Figure 2 discloses fabricating microchannels "in a silicon or glass cover that is anodically bonded or

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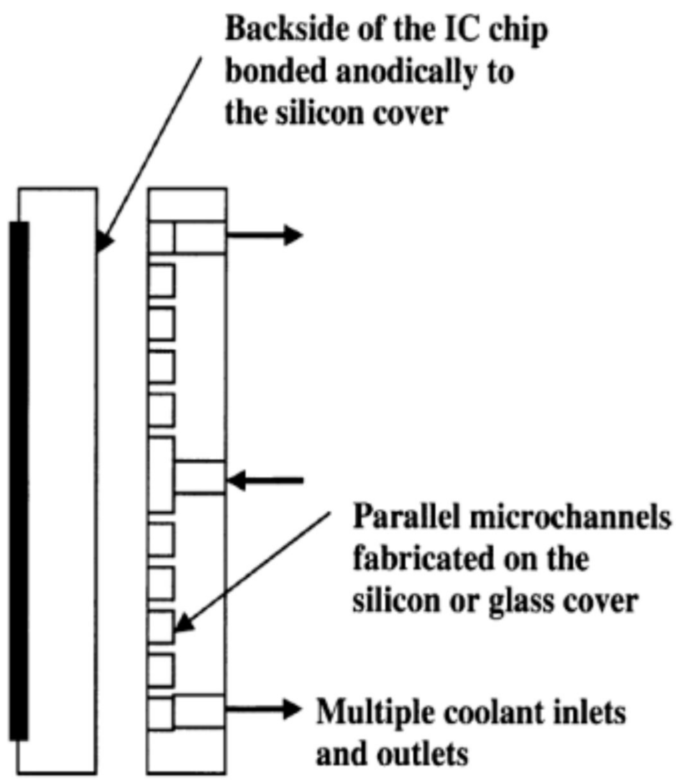
[5] Asetek has not produced any samples of this alleged design around, nor even any CAD files. Should Asetek be permitted to advance a design around position in this case, I reserve the right to examine Asetek's product and opine on whether the specific structure would infringe (*e.g.*, under the doctrine of equivalents).

glued to the back side of the chip." (*Kandlikar*, p.7.) From mere review of Figure 2, a POSITA would not have discerned that there are continuous microchannels or how fluid would flow in the illustrated system.



(Kandlikar, Figure 2.)

49. *Bonde*, also cited during prosecution of the '284 and '266 patents, does not disclose a separate fluid heat exchanger from the chip to be cooled that bifurcates fluid flow into two sub-flows over the lengths of microchannels, where the two sub-flows recombine before exiting the fluid heat exchanger. *Bonde* never refers to any of its embodiments as "split-flow" or "bifurcating" fluid flow, and the descriptions

of FIGs. 6 and 7 do not clearly disclose bifurcating fluid flow into two sub-flows over continuous microchannels. In any event, the two sub-flows do not recombine.

50. Dr. Tuckerman also points to Asetek's patents, but none of Asetek's patents disclose "**microchannels**," let alone bifurcating a fluid flow into two sub-flows over the lengths of microchannels. Rather, Asetek's patents disclose the following "channels" as shown in Figure 9 of the Asetek patents. These channels are not "**microchannels**," as Asetek's CEO (and the named inventor of the Asetek patents) Mr. Ericksen admitted during deposition: "Q: So just to clarify. The channels that are shown in figure 9 are greater than 1 millimeter? … THE WITNESS: Yes, that would be my understanding." (Eriksen Depo. Tr. (Aug. 24, 2021), 45:12-17.)

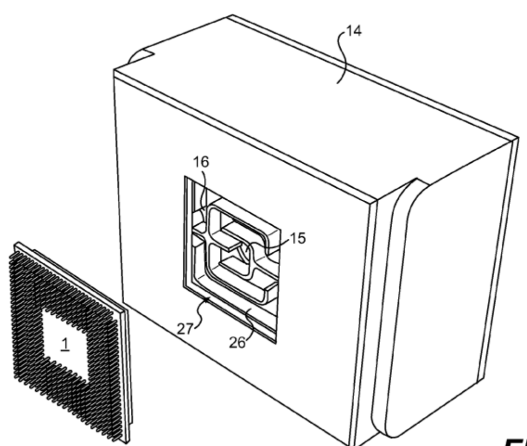


FIG. 9

(*E.g.*, U.S. Patent No. 8,240,362, FIG. 9.) It is telling that although Dr. Tuckerman identifies these references in Section VII of his report, Asetek has not relied on any

of these references as a ground to challenge the validity of the Asserted CoolIT Patents.

51. In addition, though Asetek attempted to use *Kandlikar* and *Bonde* in IPR2020-00825 to argue that a POSITA would have known to modify structures that had multiple inlets and outlets, the USPTO Patent Trial & Appeal Board ("PTAB") nevertheless confirmed the patentability of claims 13-15 of the '266 patent over Asetek's challenge. (IPR2020-00825 (Paper 50), at 38-39.)

52. Dr. Tuckerman also references *Antarctica* and *Danger Den-RBX*, but neither of those devices have microchannels, as I further discuss below.

53. I have been informed that CoolIT is currently asserting the following claims, which I further discuss below:

a. '330 patent, claims 1, 4, 12, 14, and 15;

b. '284 patent, claims 3, 5, 15, and 20; and

c. '266 patent, claims 13 and 15.

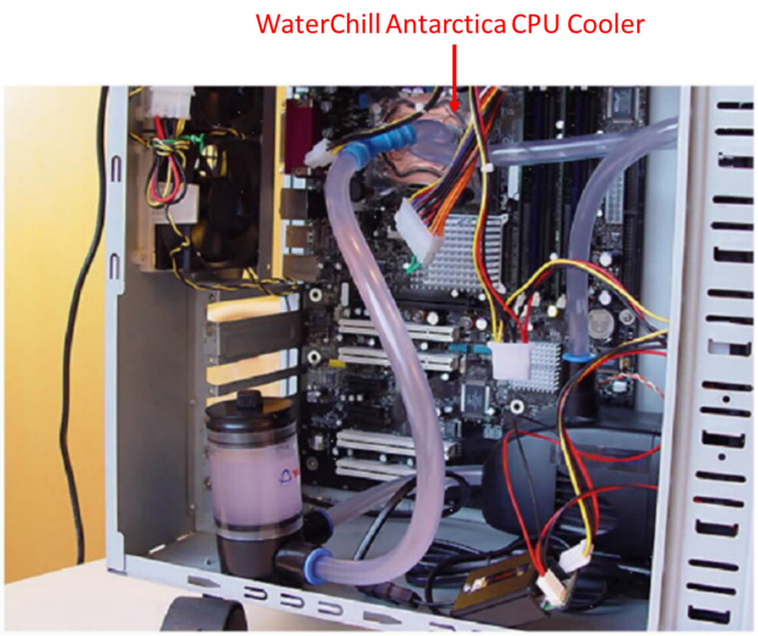
VII. SUMMARY OF DR. TUCKERMAN'S ASSERTED REFERENCES

A. *Antarctica*

54. The Asetek WaterChill Antarctica Water Cooling Kit ("*Antarctica*") was a commercial liquid cooling product that Asetek developed and purportedly released around 2004. (*See* ASE-CLT00044691-44701, ASE-CLT0004472-00044726,

ASE-CLT00044729-44731.) Dr. Tuckerman opines in his opening report that *Antarctica* anticipates and/or renders obvious all of the currently asserted claims of the Asserted CoolIT Patents. (*See generally* Tuckerman Op. Rep., Ex. A, Charts I, II; *id*, Ex. B, Chart I; *id*., Ex. C, Chart I.)

55. *Antarctica* is the CPU Cooler in Asetek's WaterChill liquid cooling system:



(ASE_CLT00044721, ASE_CLT0044707; *see also* Tuckerman Op. Rep., ¶55 (describing *Antarctica* as "a fluid heat exchanger that is connected to a prior art

pump, a prior art reservoir, and a prior art radiator in a closed loop using ½ inch and 10 mm hoses.").) The *Antarctica* comprises a continuous/monolithic plastic structure with a central inlet duct and two outlet ducts on either side of the inlet duct. A gasket is inlaid on the underside of the continuous/monolithic plastic structure and surrounds the apertures that define the inlet and outlet ducts. The continuous/monolithic plastic structure is mounted via screws, springs, and washers at four separate corners to a heat spreader plate, and the entire assembly is further mounted and thermally bonded to a CPU chip using a heat conduction compound:

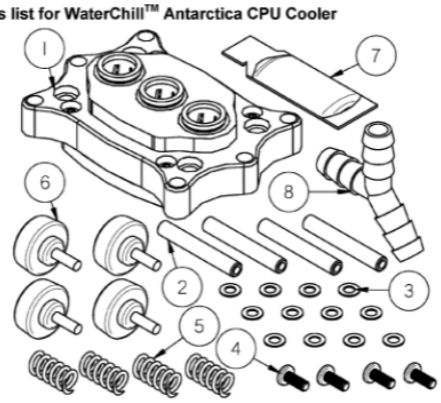

Parts list for WaterChill™ Antarctica CPU Cooler

Figure 2

Part No.	Part name	Quantity
1	WaterChill™ Antarctica CPU Cooler	1
2	Guide	4
3	Washer	12
4	Screw	4
5	Spring	4
6	Thumb Screw	4
7	Heat Conduction Compound	1
8	Y – Fitting (The appearance of the actual fitting can differ from the drawing)	1

WaterChill™ Antarctica CPU Cooler 3

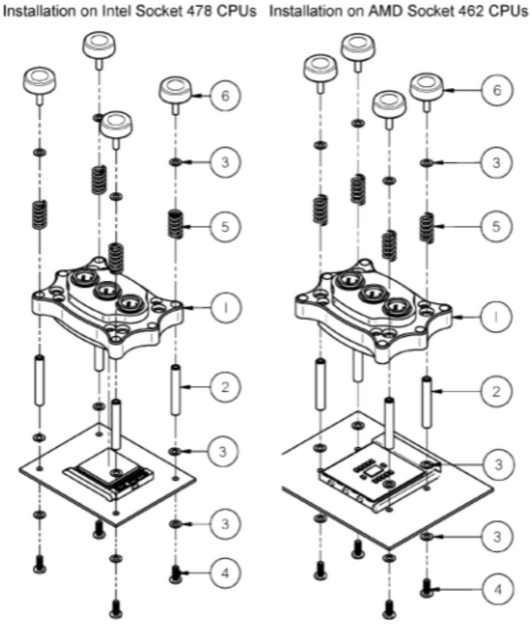

Installing the WaterChill™ CPU Cooler
Part numbers refer to parts in Figure 2.

Figure 3

Figure 4

NOTE... *Apply a thin layer of Heat Conduction Compound on the Chip before installing the WaterChill™ CPU Cooler.*

(ASE-CLT00045008, ASE-CLT00045009.)

B. *Chang*

56. Dr. Tuckerman appears to rely on U.S. Patent No. 7,259,965 to Chang et al. ("*Chang*") to inform a POSITA's modifications to *Antarctica* to include a "separate housing and plate and a seal therebetween" in his analysis related to the asserted claims of the '330 patent. (Tuckerman Op. Rep., ¶74.) I fundamentally disagree that a POSITA would have had any motivation to seek *Chang*'s teachings, or that a modified *Antarctica* practices the asserted claims of the '330 patent for the reasons I provide in Sections VIII.A and VIII.B.

57. Although Asetek and Dr. Tuckerman have not asserted *Chang* as a primary reference,[6] I nevertheless address several aspects of *Chang* to show that it does not practice the asserted claims of the '330 patent.[7] *Chang* describes several microchannel assemblies directed to cooling integrated circuits. Dr. Tuckerman cites to *Chang*'s FIG. 4 single-pass flow embodiment where a microchannel assembly includes a cover plate **410** positioned on a microchannel structure **408**:

---

[6] I understand that the Court struck *Chang*-based grounds for the '330 patent from Asetek's invalidity contentions on principles of IPR estoppel. (*See* Dkt. No. 98.)

[7] The foregoing deficiencies are exemplary. As I explain below, I reserve my right to supplement this report and identify additional deficiencies in *Chang* if Dr. Tuckerman shifts and/or expands his reliance on *Chang*.

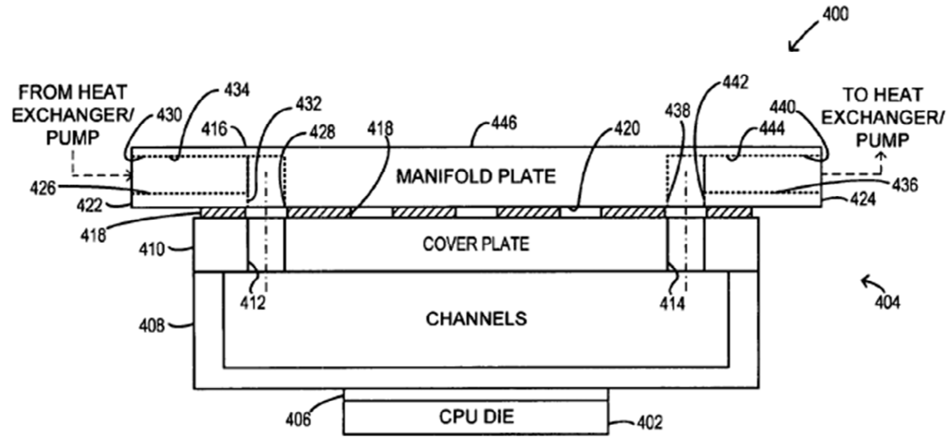


FIG. 4

(*Chang*, FIG. 4; *see also id.*, 9:5-7.) A manifold plate **416** is mounted to cover plate **410**. (*Id.*, 5:14-15.) Coolant flows in by a port **430** through an inlet passage **426** formed within manifold plate **416**. (*Id.*, 5:27-31, FIG. 4.) Passage **426** continues therethrough manifold plate **416** and cover plate **410** into microchannel structure **408**, where fluid exits the structure by outlet passage **436** through cover plate **410** (via outlet port **414**) and out through port **438** of manifold plate **416** to a port **440**. (*Id.*, 5:27-55, FIG. 4.) Critically, this embodiment lacks a plate with an "**elongate [fluid inlet opening]**" that is "**so positioned over the plurality of fins as to define a first fluid outlet opening from each microchannel in the plurality of microchannels at each of the microchannel first ends and an opposite fluid**

outlet opening from each microchannel in the plurality of microchannels at each of the microchannel opposite ends" as required for claim 1. Cover plate **410** does not define a fluid outlet opening for each microchannel "**at each of the microchannel opposite ends**."[8]

---

[8] For similar reasons, *Chang*'s FIG. 4 embodiment also fails to satisfy: (1) claim 12's requirement of a "**plate**" that "**defines an elongate aperture extending transversely relative to each of the plurality of juxtaposed microchannels, wherein the elongate aperture is positioned between the first ends and the second ends of the plurality of juxtaposed microchannels**." This embodiment also fails to satisfy claim 14's requirement of a "**housing … wherein the inlet opens to an inlet header region juxtaposed with a first side of the plurality of juxtaposed fins, and wherein the outlet opens from an outlet header region juxtaposed with a second side of the plurality of juxtaposed fins**" because manifold plate **416**'s inlet/outlet does not open to an inlet/outlet header region juxtaposed to either side of the microchannel structure. The inlet/outlet opens to a port of cover plate **410**.

58. Dr. Tuckerman primarily relies on an alternate embodiment in *Chang*'s FIGs. 11 and 13 in his mapping, and points to thin disclosures[9] in *Chang* to suggest that *Chang*'s FIG. 4 embodiment may be adapted to permit a centrally-located inlet to the microchannel structure and two opposing outlets:

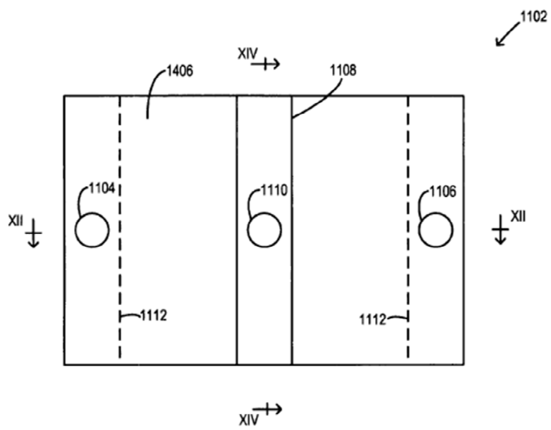


FIG. 11

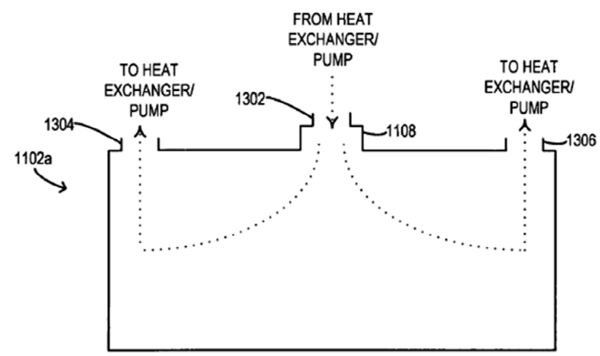


FIG. 13

[9] Specifically, Dr. Tuckerman refers to *Chang*'s non-enabling disclosure that "[t]he various embodiments described above may be combined in a variety of ways. For example, the manifold plate (*Id*., FIGS. 4, 5) … may be used in conjunction with … the reduced flow length inlet/outlet arrangement of FIGS. 11-14." (Chang, 9:55-60.) Neither *Chang* nor Dr. Tuckerman provide any explanation as to how manifold plate **416** would have had to be adapted to be incorporated into the arrangements represented by FIGs. 11-14.

(*Id.*, FIGs. 11, 13; *see also id.*, 9:46-54; Tuckerman Op. Rep., ¶63.) However, Dr. Tuckerman only offers conclusory assertions informed by hindsight to explain why a POSITA would combine this alternate embodiment with the embodiment in FIG. 4 to disclose a "**housing spaced [apart] from a plate**" recited in claims 1, 12, and 14. (Tuckerman Op. Rep., Ex. A, Chart II, pp. 14, 32-33, 53-54.) And, in any event, Dr. Tuckerman provides no explanation for why a POSITA would have considered manifold plate **416** to be a "**housing**" instead of merely another plate. Manifold plate **416** does not enclose or house anything other than coolant passages, just like the cover plate / lid. It is stacked with a cover plate / lid, in contrast with how the'330 patent describes the term. (*See* '330, FIGs. 1-3 (depicting a housing **109** and heat spreader plate **102** defining outer limit of the heat sink), 2:42-48 (describing same), FIG. 5 (depicting top cap **244** installed over heat exchanger assembly), 7:7-16 (describing same).) In sum, a POSITA reviewing *Chang* would not have equated manifold plate **416** with a "**housing**."

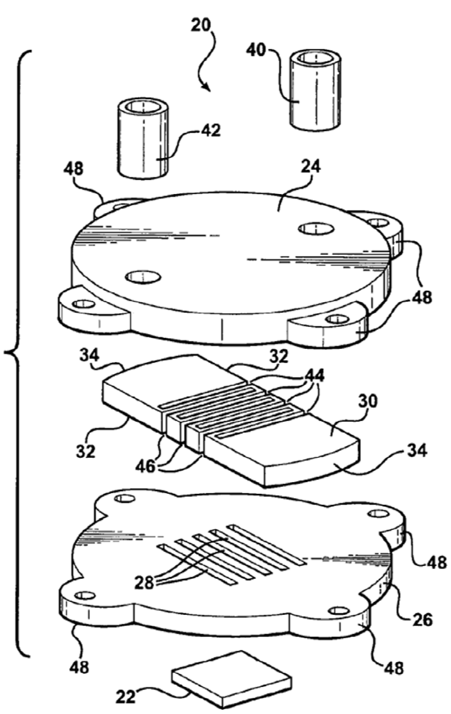
C. *Bhatti*

59. Dr. Tuckerman opines in his opening report that the '284 patent's claims 3, 5, 15, and 20 are anticipated and/or obvious over U.S. Patent Appl. Pub. No. 2007/0163750 to Mohinder Singh Bhatti et al. ("*Bhatti*"). (*See generally* Tuckerman Op. Rep., Ex. B, Chart II.) *Bhatti* discloses a microchannel heat sink. (Bhatti,

Abstract.) However, it is my understanding that the applicant disclosed the *Bhatti* reference before the USPTO in an information disclosure statement during prosecution of the underlying application to the '284 patent. I further understand that the Examiner considered and found the '284 patent claims (including claims 3, 5, 15, and 20) patentable over *Bhatti* during examination—a conclusion I agree with for the reasons discussed in Section IX.D.

60. *Bhatti* discloses a specific heat sink configuration to transfer heat from a heat source or electronic component to a coolant fluid. (Bhatti, [0015].) FIG. 3 depicts an exploded view of *Bhatti*'s heat sink **20**, reproduced below:

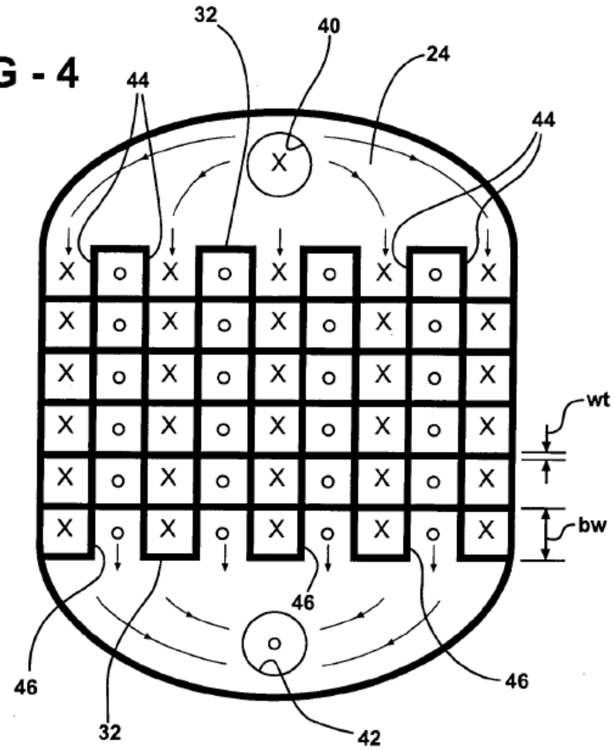
FIG - 3



(*Id*., FIG. 3.) *Bhatti* explains that heat sink **20** is defined by housing that includes lid **24** and base **26**, where base **26** is a flat cold plate "having a top surface and a bottom surface and parallel micro-channels **28**." (*Id*., [0016].) Disposed between lid **24** and base **26** is manifold plate **30**. (*Id*., [0017].) The periphery of lid **24** engages with base **26**, whereas an interior shoulder **36** of lid **24** (not shown) engages with ends **34** of manifold plate **30** to define a recessed surface **38** within the periphery of lid **24**. (*Id*.; *see also id*., FIG. 2.) This heat sink configuration lacks what a POSITA would have understood to be a seal between the surfaces of manifold plate **30**, lid **24**, and base **26**, as I explain in my analysis below.

61. Manifold plate **30** includes inlet manifold channels **44** extending into an inlet edge **32** and outlet manifold channels **46** extending into an outlet edge **32.** **(***Id*., [0018].) The inlet manifold channels **44** alternate with the outlet manifold channels **46** to define rectangular cells with X indicating flow into channels **44**, **46**, and O indicating flow out of channels **44**, **46**, as depicted in FIG. 4:

FIG - 4

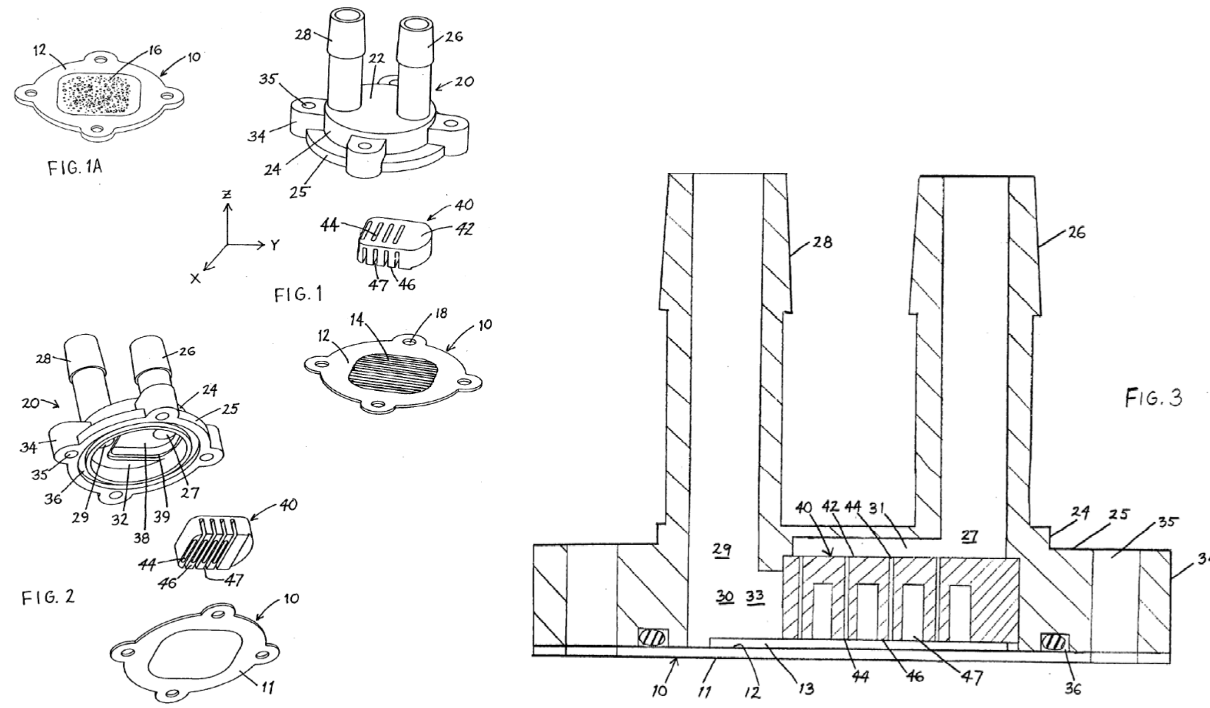


(*Id*., FIG. 4; *see also id.*, [0018], [0021].)

D. *Kang*

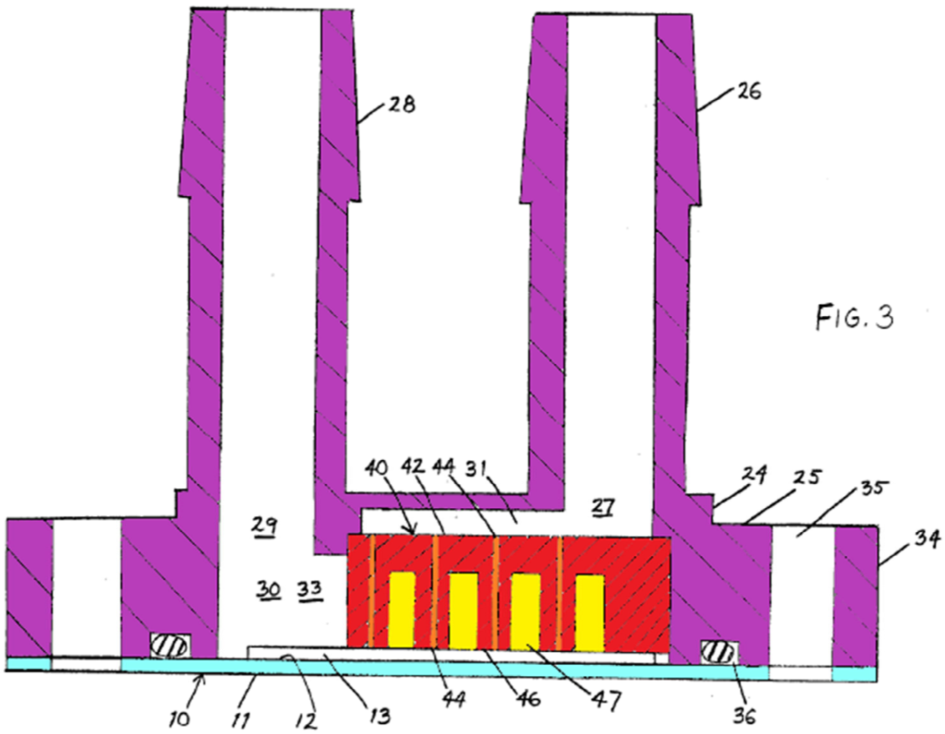
62. Dr. Tuckerman opines in his opening report that the '284 patent's claims 3, 5, 15, and 20 are also obvious over U.S. Patent Appl. Pub. No. 2006/0096738 to Sukhvinder Singh Kang et al. ("*Kang*"). (*See generally* Tuckerman Op. Rep., Ex. B, Chart III.) Like *Bhatti*, I understand that the Examiner considered and found the '284 patent claims patentable over *Kang* during prosecution.

63. *Kang* discloses a liquid cold plate heat exchanger. (Kang, [0003].) Dr. Tuckerman relies on *Kang*'s heat exchanger shown in FIGs. 1-3, reproduced below:



(*Id*., FIGs. 1-3; *see also id.*, [0019]-[0022].) *Kang*'s device includes a cooling plate **10** having a heat collection surface **11** for placing against an object to be cooled and opposing heat transfer surface **12**. (*Id*., [0028].)

64. Annotated FIG. 3 below shows a cover **20** (purple) over the cooling plate **10** (blue) forming a chamber **30**, in addition to an inlet nipple **26** and an outlet nipple **28**:



(*Id*., FIG. 3 (annotated).)

65. Cover **20** also defines a first recess **32** (depicted in FIG. 2) and, from the bottom of that first recess, a second recess **38**. (*Id*., [0028], FIG. 2.) Second recess **38** defines a shoulder **39** against which flow distributor **40** (in red) rests, spacing flow distributor **40** from the bottom of second recess **38** to form an inlet section **31**. (*Id*.) Flow distributor **40** includes parallel slots **44** (in orange above) extending between inlet section **31** and outlet section **33**, and outlet channels **47** (in yellow above) that separate a plurality of coplanar lands spaced from heat transfer surface **12** by gaps **48**. (*Id*., [0029].) Fluid travels downward through the slots **44**, within

the gaps **48** along the fins **13** and **14**, back up into the outlet channels **47**, and then along outlet channels **47** into outlet section **33**. (*Id.*, [0030].)

E. *Hamilton*

66. Dr. Tuckerman opines in his opening report that the '284 patent's claims 3, 5, 15, and 20 are anticipated and/or obvious over U.S. Patent No. 5,998,240 to Robin E. Hamilton et al. ("*Hamilton*"). (*See generally* Tuckerman Op. Rep., Ex. B, Chart IV.) And, just as with *Bhatti* and *Kang*, I understand that the Examiner considered and found the claims patentable over *Hamilton* during prosecution.

67. *Hamilton* discloses a semiconductor device with microchannels etched directly into a heat source (*e.g.*, a silicon and/or silicon carbide chip) to promote efficient liquid cooling as close as possible to the heat source. (Hamilton, Abstract.) Dr. Tuckerman's mapping relies primarily on *Hamilton*'s second embodiment, a semiconductor structure depicted in FIG. 12:

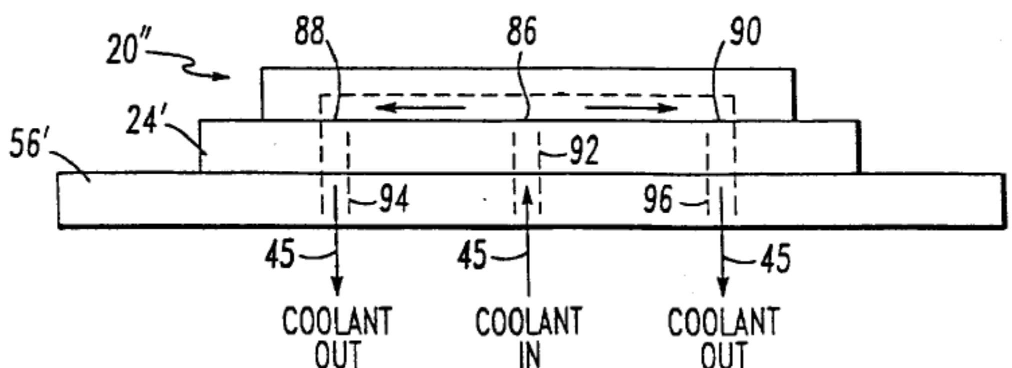
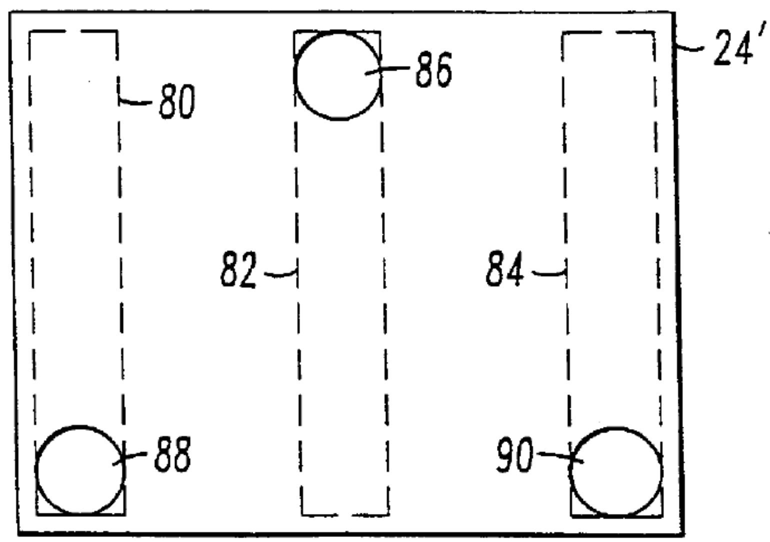


FIG. 12

(Hamilton, FIG. 12.)

68. Silicon chip/die **20″** comprises a plurality of insulated gate bipolar transistors (IGBT) having a common upper emitter region **72**, underlying common region **74**, and respective interdigitated gate electrodes **76**. (*Id*., 6:27-32.) Beneath the common region **74** lies region **78** containing a plurality of microchannels **68′**, which are close-ended and run parallel to each other and are of substantially the same size. (*Id*., 6:32-38.) Chip/die **20″** sits on ceramic frame **24′**, which includes three generally rectangular coolant manifolds **80**, **82**, and **84** as shown:

FIG.11



(*Id*., 6:44-47, FIG. 11.)

69. *Hamilton* describes how middle manifold **82** comprises a coolant input manifold having a coolant inlet port **86** that forms at one end. (*Id*., 6:47-49.) Outer

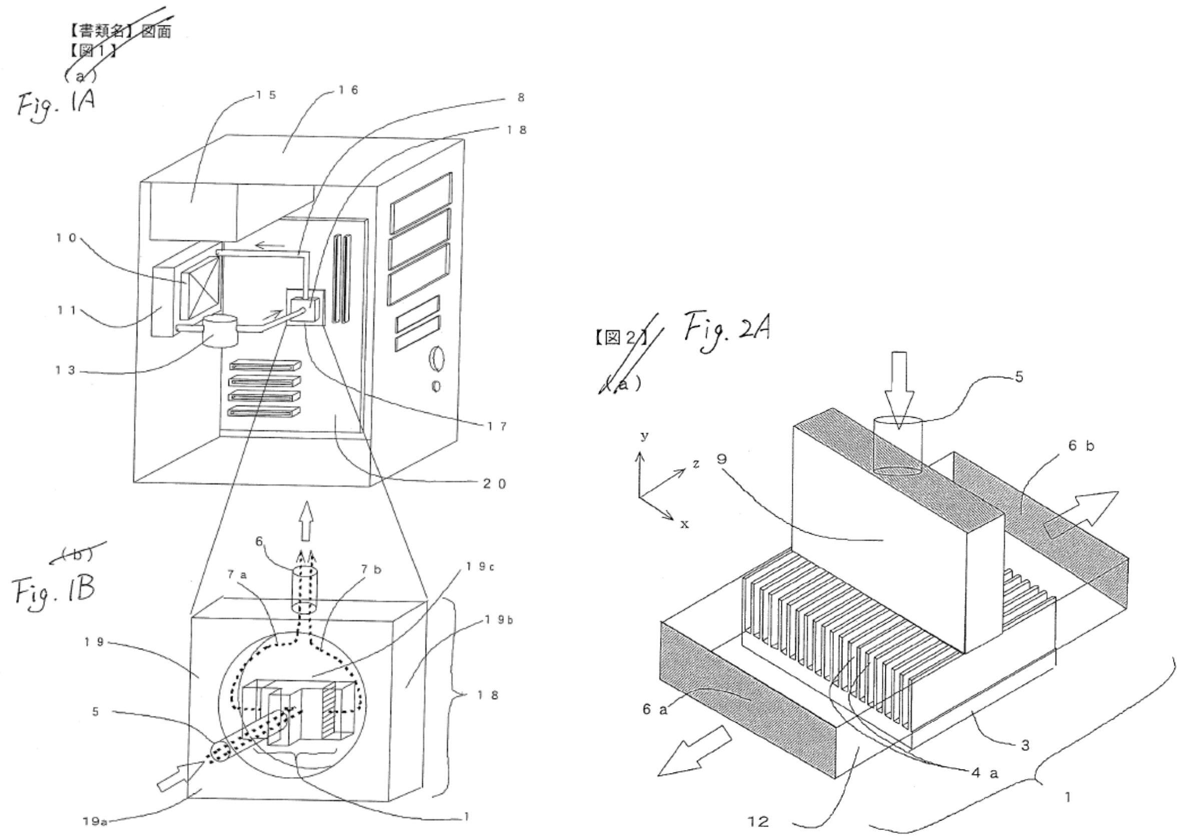
manifolds **80** and **84** comprise output manifolds, including respective coolant outlet ports 88 and **90** at the opposite end of inlet port **86**. (*Id*., 6:50-52.)

70. Coolant flows as shown in FIG. 12. Chip/die **20″** and ceramic substrate **24′** are stacked and mounted to ground plane **56′**, which has a single coolant input duct **92** and two output ducts **94** and **96**. (*Id*., 6:54-58.) Coolant flows from ground plane **56′** into ceramic substrate through input duct **92**, then appears to run along middle manifold **82** until flowing into the microchannels of chip/die **20″** via inlet port **86**. (*Id*., FIGs. 11, 12.) After running to the opposite ends of the microchannels, the coolant flow collects at the outlet ports **88** and **90**, running along outer manifolds **80** and **84** respectively before flowing back to ground plane **56′** via output ducts **94** and **96**. (*Id*.)

F. *Satou*

71. Dr. Tuckerman relies on FIG. 1B from U.S. Patent Appl. Pub. No. 2007/0125526 to Kaoru Satou et al. ("*Satou*") to contend that *Satou* teaches "**a fluid outlet passage, … wherein the fluid outlet passage has a first outlet region positioned adjacent the microchannel first ends and a second outlet region positioned adjacent the microchannel second ends**" in claim 13 of the '266 patent. (*See* Tuckerman Op. Rep., Ex. C, pp. 7-8.) *Satou*'s FIG. 1B depicts a heat-receiving

unit **18** of a first embodiment of its cooling device. *Satou* shows additional aspects of its first embodiment in FIGs. 1A and 2A as well, reproduced below:



(Satou, FIGs. 1A, 1B, 2A.) *Satou*'s first embodiment comprises a heat-receiving unit **18**, a heat-radiating section **11**, a pump **13** circulating refrigerant, and flow channel **8** that connects these three components together. (*Id*., [0028].) Refrigerant flows into heat-receiving unit **18** from inlet **5**, through inflow nozzle **9** disposed longitudinally in the middle of a parallel array of plate-shaped fins **4a**. (*Id*., [0029], [0032].) The refrigerant flow bifurcates upon entering the fin array, passing through flow paths indicated by streamlines **7a** and **7b** in FIG. 2A. (*Id*., [0032].) The

bifurcated flows leave via outlets **6a** and **6b** of a heat-receiving cover **12** of heat-receiving unit **18**. (*Id.*)

VIII. OPINIONS REGARDING U.S. 8,746,330

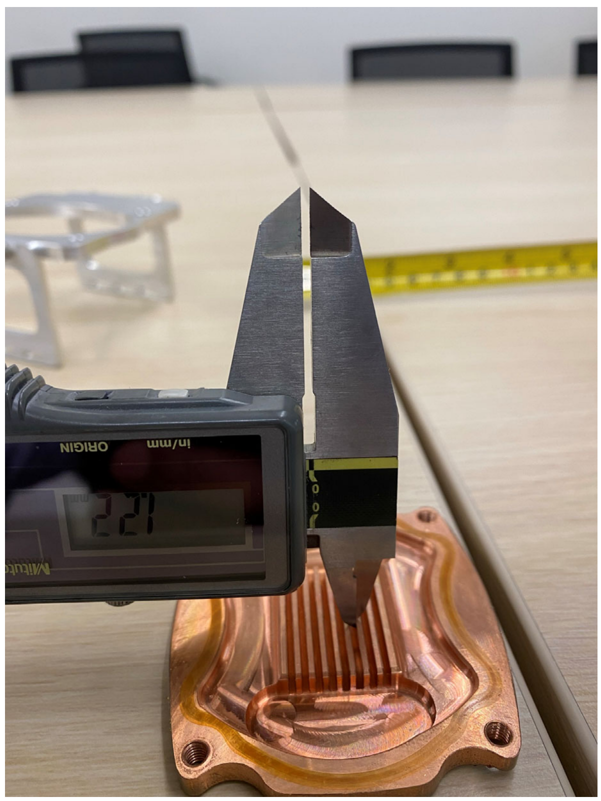
A. Dr. Tuckerman Fails to Show How *Antarctica* Renders Obvious the Asserted Claims of the '330 Patent

1. *Antarctica*'s heat spreader plate channels are not "microchannels" (Claims 1, 12, 14)

72. The term "**microchannels**" appears in the '330 patent's claims 1, 12, and 14. I understand the parties stipulated to construe "**microchannels**" as "channels with width up to 1 millimeter." (Dkt. No. 149.) Dr. Tuckerman concludes in his opening report that *Antarctica*'s heat spreader plate channels satisfy this limitation by baldly asserting that "[t]he space between adjacent fins is about 0.9 – 1.0 mm)." (Tuckerman Op. Rep., ¶57.) I respectfully disagree.

73. As an initial matter, I note that Dr. Tuckerman commits classic hindsight by citing to teachings ***from the '330 patent specification*** (*i.e.*, '330, 3:56-60) to support his position. (*Id.*) He further cites to deposition testimony from Mr. Eriksen—named inventor to the Asetek patents asserted in this action—to suggest that *Antarctica*'s channel widths are "between 0.6 and 0.8 millimeters." (Tuckerman Op. Rep., ¶57) I reviewed the cited transcript and found no evidence corroborating Mr. Eriksen's testimony.

74. Rather, empirical evidence contradicts Dr. Tuckerman's opinion on "**microchannels**." I inspected *Antarctica* on June 25, 2021 at the offices of Asetek's counsel. During my inspection, I measured each channel width in *Antarctica*'s heat spreader plate using an electronic vernier caliper. I calibrated the vernier calipers before the inspection, and the calipers are precise to a hundredth of a millimeter. In the photograph below, I show how a channel in *Antarctica*'s heat spreader plate measures a width of 1.22 mm:



(COOLIT0017125.) I collected and recorded separate measurements of width for each channel within *Antarctica*'s heat spreader plate, which ranged from 1.18 mm

to 1.25 mm. (*See* COOLIT0017062-COOLIT0017063, COOLIT0017067-COOLIT0017068, COOLIT0017094-COOLIT0017095, COOLIT0017108-COOLIT0017109, COOLIT1723-COOLIT1732, COOLIT001754-COOLIT1757, COOLIT0017164-COOLIT0017165, COOLIT0017170-COOLIT0017171, COOLIT0017173-COOLIT0017174, COOLIT0017186-COOLIT0017187, COOLIT0017196-COOLIT0017197, COOLIT0017199-COOLIT0017200.) All of *Antarctica*'s channel widths exceed 1.0 mm and do not qualify as "**microchannels**" under the parties' stipulated construction.

75. Additionally, Asetek's own October 30, 2012 press release announcing its Gen4 products shows that Asetek itself did not consider *Antarctica*'s channels to be "microchannels." (*See* Rao Depo. Tr. (Aug. 19, 2021), Ex. 158.) I note the press release never refers to *Antarctica* as having "**microchannels**" but instead refers to "combining [*Antarctica*] with newer micro-channel technology." (*Id.*)

76. As a fallback position, Dr. Tuckerman posits that a POSITA would have known that the fins in a fluid heat exchange "should be disposed in such a way that they would form microchannels between adjacent fins." (Tuckerman Op. Rep., ¶57.) He reasons that a POSITA would have understood by August 2007 that "microchannels have large surface area-to-volume ratio, and therefore, microchannels provide a large heat transfer surface area per unit fluid flow volume

as compared to macrochannels or minichannels." (*Id.*) While I agree with Dr. Tuckerman in principle that implementing microchannels in cold plates may improve heat transfer performance, his analysis glosses over numerous design and manufacturing challenges that would have deterred, rather than motivated, a POSITA in 2007 from modifying *Antarctica* to replace its channels with microchannels.

77. *Antarctica* is a fluid heat exchanger within Asetek's WaterChill liquid cooling system. In fluid heat exchangers, channels with small hydraulic diameters (*e.g.*, microchannels) increase flow resistance as compared to channels with large hydraulic diameters (*e.g.*, macro-channels) and, accordingly, increase pressure drop as a fluid passes along the length of the channel. However, channels with small hydraulic diameters also substantially increase the available surface area for heat transfer as compared to channels with larger hydraulic diameters. A fluid heat exchanger's heat transfer performance also depends on coolant flow rate through the fluid heat exchanger. A liquid cooling system's pump must have sufficient power to deliver coolant through the fluid heat exchanger at a rate that overcomes the flow resistance from the channels and minimizes the time coolant travels along the channel passages. Channel width and pump power are carefully calibrated with

dimensions and materials of other system components (*e.g.*, tubing, gaskets, Y-fittings, ports) to optimize heat transfer performance while minimizing leakage risks.

78. With these considerations at the fore, a POSITA would have appreciated that replacing *Antarctica*'s channels with microchannels is no trivial task, involving multiple modifications to the WaterChill liquid cooling system. For example, reducing channel widths within *Antarctica*'s heat spreader plate would increase the number of channels on the plate (to achieve the sought-after benefit of increased heat transfer surface area) and also require a more powerful (and thus, more expensive and/or less reliable) pump to deliver higher coolant flow rates to compensate for the increased flow resistance in the channel array. (*See, e.g.*, Chang, 1:21-29.) This increased coolant flow rate would affect the entire WaterChill system, placing increased pressure on fluidic joints throughout and increasing the risk of coolant leakage (especially in the absence of seals/gaskets).

79. In addition, manufacturing limitations and cost inefficiencies would have deterred a POSITA in 2007 from implementing microchannels in *Antarctica*'s heat spreader plate. *Antarctica*'s heat spreader plate is comprised of soft copper, and markings at the fins indicate Asetek machine-milled the fin array on the spreader plate. I measured *Antarctica*'s fin widths, and all exceed 1.0 mm. (*See* COOLIT0017076, COOLIT0017084, COOLIT0017097, COOLIT0017099,

COOLIT0017104, COOLIT0017106, COOLIT0017115, COOLIT0017117, COOLIT0017121, COOLIT0017135, COOLIT0017147, COOLIT0017152, COOLIT0017162, COOLIT0017166, COOLIT0017181, COOLIT0017189, COOLIT0017201, COOLIT0017203.) There is no heat transfer benefit for this thickness; it indicates a limitation during the commercial machining process. Indeed, while possible to implement microchannels in a copper plate, the fabrication process is exceedingly expensive and technically difficult. (*See* H. Pokharna et al., "Microchannel Cooling in Computing Platforms: Performance Needs and Challenges in Implementation," ASME 2004 2nd Int'l Conf. on Microchannels and Minichannels (January 2004); *see also* Chang, 1:34-42 (observing that increasing the height-width aspect ratio in channels increases manufacturing costs).) A POSITA in 2007 would have understood by inspecting *Antarctica*'s heat spreader plate that it was not commercially feasible to machine-mill soft copper fins with adjoining channel widths less than 1.0 mm, particularly for use in split-flow designs, and would have been discouraged from doing so.

80. In a separate section of his report, Dr. Tuckerman points to his thesis and several additional references to support his assertion that "microchannels were used in high-performance heat sinks/fluid heat exchangers since the early 1980s." (Tuckerman Op. Rep., ¶69.) These references are by no means a roadmap for

implementing microchannels in *Antarctica*. *Kandlikar* references its prior publication and Dr. Tuckerman's thesis, but each discuss microchannels in silicon chips having different materials properties and corresponding methods of manufacturing. *Hamilton* and *Bonde* also disclose silicon / silicon carbide microchannels and related processes particular to working with this material. (*See Hamilton*, 2:9-17; *Bonde*, 3:2-11.) *Kang* refers only to microfins. (*See infra*, Section IX.E.) *Bhatti* refers to microchannels but is silent as to the materials and fabrication process used. Only *Chang* suggests forming microchannels using copper and suggests a dry-etching technique, and it deals with channels of significantly smaller widths than in *Antarctica*. It does not address technical challenges or costs in manufacturing copper microchannels at a commercial scale, or with split-flow designs.

81. In any event, Dr. Tuckerman has not articulated a more particularized reason why a POSITA in 2007 would have been motivated to modify *Antarctica* in view of these considerable technical and manufacturing challenges. According to Dr. Tuckerman, *Antarctica* came to market in 2004. He provides no evidence that Asetek ever implemented microchannels in *Antarctica*, let alone in the three years before CoolIT filed its provisional application to the '330 patent. It is unclear whether Asetek considered using microchannels during this time either. The Asetek

Asserted Patents[10], claiming priority dates between 2004-2007, refer to fluid heat exchangers with channels, not microchannels. Presumably, Asetek would have implemented microchannels in *Antarctica* if technically feasible and commercially viable to do so. The fact that it did not, and that its intellectual property is tellingly silent as to microchannels, would have discouraged a POSITA from modifying *Antarctica* to include microchannels.

2. *Antarctica* lacks "a housing spaced from the plate," let alone a "plate" (Claims 1, 12, 14)

82. Claims 1, 12, and 14 each recite, in part, "**a housing spaced apart from the plate**." FIGs. 1 and 3 depict the claimed arrangement of these components:

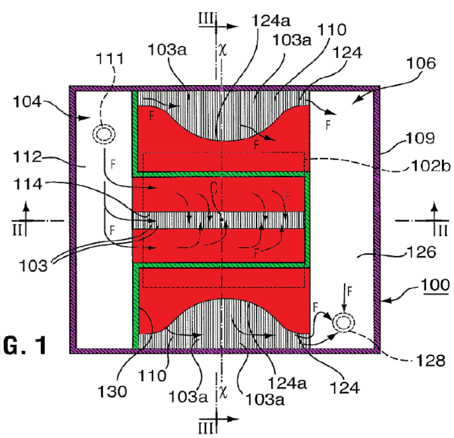
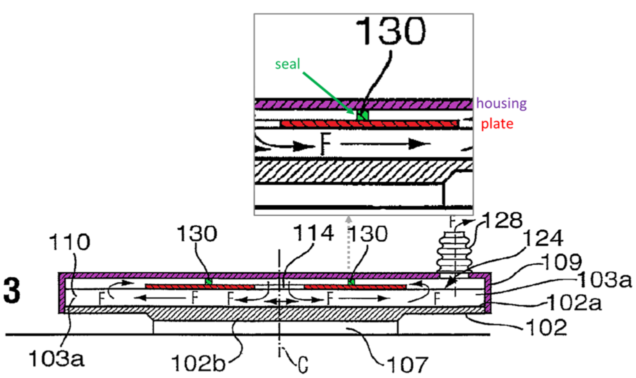


FIG. 1

FIG. 3

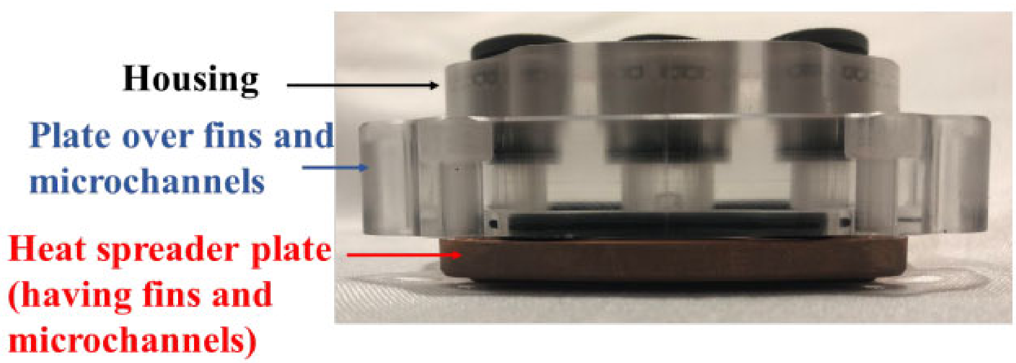


('330, FIGs. 1, 3.) The specification explains that fluid heat exchanger **100** includes a heat spreader plate **102**, and that a housing **109** (in purple) operates with heat

[10] U.S. Patent Nos. 8,240,362; 10,599,196; 10,613,601.

spreader plate **102** to form an outer limit of the heat sink and to define fluid flow passages **104** and **106**. (*Id*., 2:42-48.) Fluid passes along inlet passage **104** and through an inlet opening **114** defined by a plate (in red), into microchannels **103** extending from heat spreader plate **102**, and toward outlet openings **124**. (*Id*., 4:49-51; 6:13-33.) This fluid continues to flow through fluid outlet passage **106**, which includes one or more fluid outlet openings **124** from microchannels **103**, a header **126**, and an outlet port **128** opening from the housing. (*Id*., 5:1-5.) Housing **109** and the plate defining inlet opening **114** are separated by seal **130** (in green), which fills the gap between these two structures. (*Id*., 6:52-55.)

83. Dr. Tuckerman maps "**plate**" and "**housing**" to two regions of the same continuous/monolithic plastic structure:



(Tuckerman Op. Rep., ¶56.) By his own admission, Dr. Tuckerman's mapping of a "**plate**" and "**housing**" "comprise a <u>continuous/monolithic structure</u>,…" (*Id*., ¶65

(underlining added).) Spacing does not exist between these two regions. It is thus my opinion that *Antarctica* lacks a "**housing spaced apart from the plate**."

84. At base, I disagree with Dr. Tuckerman's mapping of a "**plate**" and "**housing**" to different regions of *Antarctica*'s continuous/monolithic structure. He provides no principled explanation for why a POSITA would have divided *Antarctica*'s continuous/monolithic structure into two regions as opposed to classifying the structure as a unitary housing. The '330 specification informs the claimed "**housing**," and explains how it operates with a heat spreader plate "to form an outer limit of the heat sink" and to define fluid flow passages within the heat sink. ('330, 2:42-48; *see also id*., FIGs. 1-3 (depicting housing enclosing split-flow plate).) This housing is installed over the fluid heat exchanger assembly in each embodiment; it encloses the assembly. (*Id.*; *see also id.* 7:7-16, FIGs. 4-5.) A POSITA would not have understood Dr. Tuckerman's identified region within *Antarctica*'s plastic structure to be "**housing**" because it does not house or enclose any part of the fluid heat exchanger assembly. It is merely stacked on Dr. Tuckerman "**plate**" region within the same continuous/monolithic structure. The mere fact that inlet and outlet ducts pass therethrough—also present in Dr. Tuckerman's "**plate**" region—does not transform this region into "**housing**." If this structural feature alone was sufficient

to identify the "**housing**," Dr. Tuckerman's mapping would amount to little more than an exercise in arbitrary line-drawing to arrive at the claims—which it is.

85. Instead, a POSITA inspecting *Antarctica* would have naturally mapped the entire continuous/monolithic structure to the claimed "**housing**." Analogous to the '330 patent's "**housing**" description, *Antarctica*'s plastic structure operates with its heat spreader plate to form an outer limit of the fluid heat exchanger and it further defines inlet and outlet passages within the assembly. Absent from this more natural interpretation of *Antarctica* is the claimed "**plate**." These additional reasons make clear that *Antarctica* lacks a "**housing spaced apart from the plate**," let alone a "**plate**."

86. If I were to assume Dr. Tuckerman's region-mapping of "**plate**" and "**housing**" was valid, *Antarctica*'s plastic structure still fails to show a housing "**spaced apart**" from a plate. A POSITA reading "**spaced apart**" under its plain meaning would have understood it to define a spatial relationship between the claimed plate and housing, and that these structures are both physically distinct and separate from each other. This understanding would have been confirmed by the additional limitation that a "**seal extend[s] between the plate and the housing**." Every embodiment in the '330 patent describes and supports the plain meaning. (*See* '330, FIGs. 1-5, 2:42-48, 6:52-55, 7:7-16 (describing plate **240** and seal **230** as

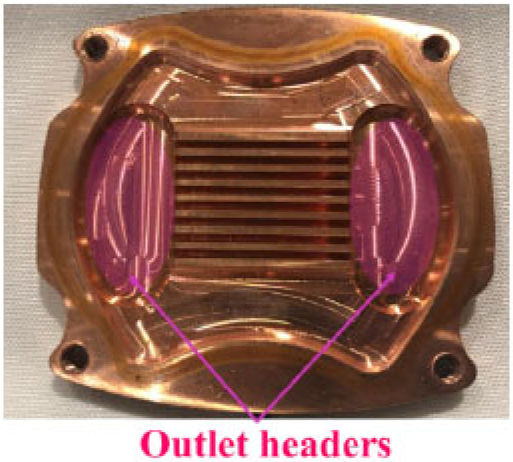
separate and distinct from top cap **244**).) As *Antarctica* lacks a physically distinct and separate "**plate**" and "**housing**" structure under Dr. Tuckerman's mapping, it fails to disclose this limitation.

87. If I were to once again assume that a POSITA could identify a separate housing and plate within *Antarctica*'s continuous/monolithic structure, Dr. Tuckerman cites two abutting regions as disclosing "**spaced apart**." Abutment cannot mean two structures are "**spaced apart**" because such an interpretation (1) renders the claim language meaningless; and (2) fails to consider that "**a seal extending between the plate and the housing**" requires that a gap exist between the housing and the plate. (*See also* Dkt. No. 149 (construing "**seal**" as "**a component that fills a gap to prevent leakage through the gap**").)

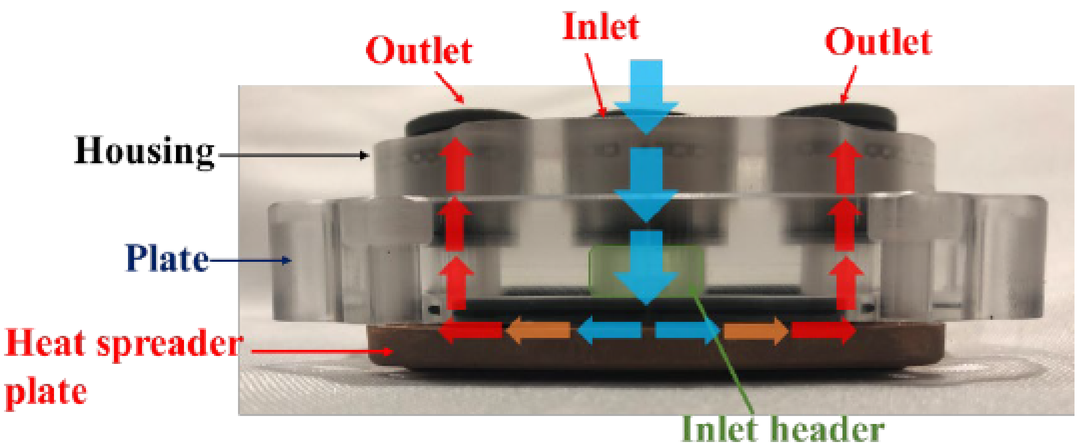
3. *Antarctica* does not disclose "wherein … the outlet [defined by the housing] [aperture] opens from [the / an] outlet header [region]" (Claims 1, 12, 14)

88. Claim elements 1.4 and 14.3 further recite that the "**housing defines … an outlet, wherein … the outlet [defined by the housing] opens from the outlet header**." Claim element 12.3 mirrors this claim language, except it recites an "**outlet aperture**" defined by the housing rather than an "outlet." It is my opinion that Dr. Tuckerman also does not show how *Antarctica* satisfies these limitations.

89. Dr. Tuckerman maps the claimed "**outlet header**" to two recessed regions adjacent to *Antarctica*'s channel array on its heat spreader plate:

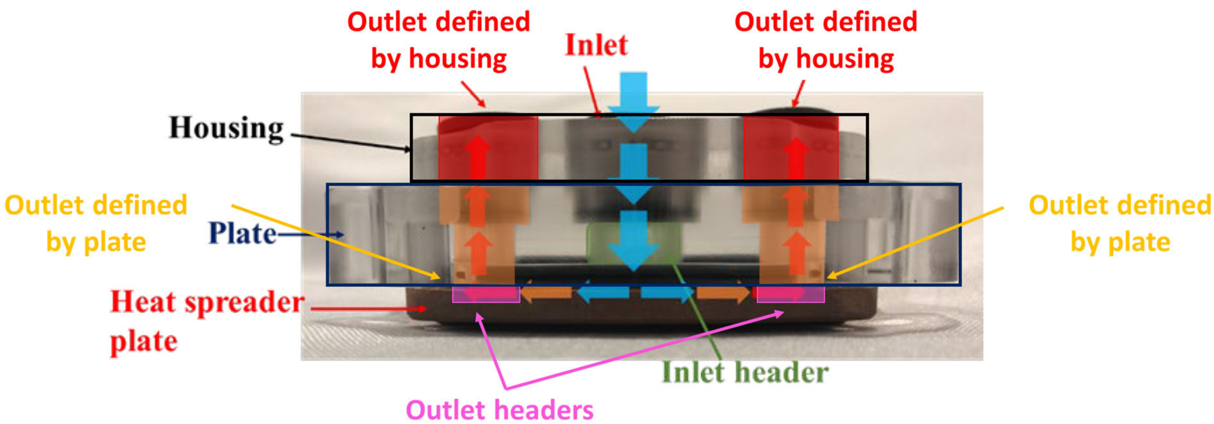


(Tuckerman Op. Rep., Ex. A, Chart I, pp. 4, 12, 18.) He further maps two openings at the top of *Antarctica*'s continuous structure as the claimed "**outlets**" in the housing:



(*Id*., pp. 5, 12, 18.) But the "**outlet**" does not open from the outlet headers. Dr. Tuckerman's mapping of "**housing**" and "**plate**" to *Antarctica* prohibits this

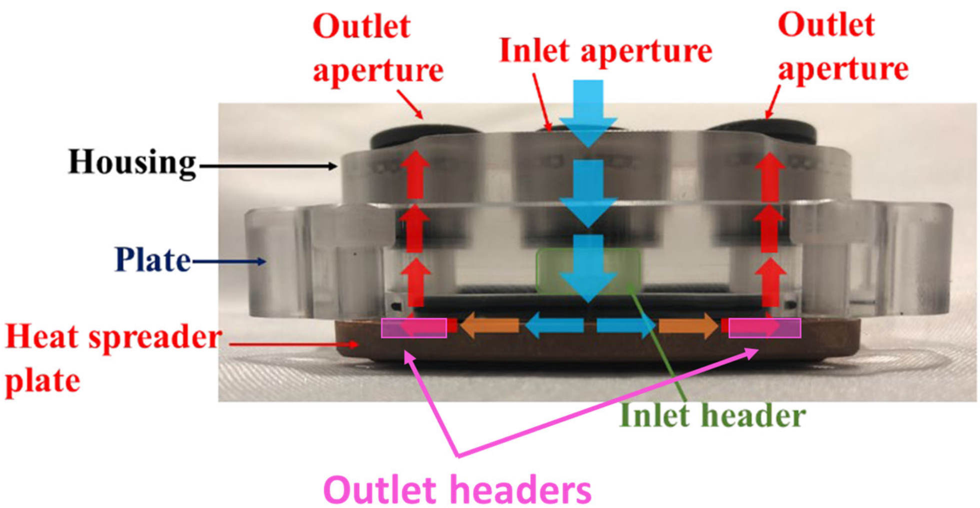
arrangement. The "**plate**" is positioned between the "**housing**" and the "**outlet header**," such that the "**outlet**" at the housing opens from an outlet defined by the "**plate**," not from the claimed "**outlet header**." I overlie my annotations onto Dr. Tuckerman's to highlight the deficiency in his mapping:



(*Id*. (annotated).) As shown above, fluid flows from the outlet headers through outlets defined by the plate before entering outlets defined by the housing. The outlet defining the housing opens from the outlet defining the plate in Dr. Tuckerman's mapping.

90. Claim element 12.3's use of the term "**opening aperture**" confirms the deficiencies in Dr. Tuckerman's mapping. A POSITA would have understood the term "**aperture**," according to its plain meaning, to connote a two-dimensional hole or gap where fluid exits one structure and enters another. (*See* Dkt. No. 67, Ex. B, ¶33 (proposing plain meaning as "hole or gap"), Dkt. No. 149 (adopting plain

meaning); *see also* Dkt. No. 67, at 23-26 (providing intrinsic and extrinsic support for plain meaning of "aperture").) Dr. Tuckerman identifies the "**outlet aperture**" as the opening at the extremity of the *Antarctica*'s continuous/monolithic structure, opposite the side abutting the heat spreader plate:



(*Id*., p. 12 (annotated).) While claim element 12.3 requires that "**the outlet aperture opens <u>from</u> an outlet header region**," Dr. Tuckerman's "**outlet aperture**" is twice-removed from the outlet header region. It opens from an outlet passage within Dr. Tuckerman's identified "**housing**" which in-turn opens from an outlet passage in his mapped "**plate**."

91. For these reasons, it is my opinion that Dr. Tuckerman has also failed to show how *Antarctica* discloses or renders obvious "**a housing spaced from the plate …**

wherein the outlet [defined by the housing] [aperture] opens from the outlet header [region]."

4. *Antarctica* lacks a "seal extending between the [housing / plate] and the [[apertured] plate / housing]" and a POSITA would not have been motivated to modify *Antarctica* to include a "seal" (Claims 1, 12, 14)

92. Claims 1, 12, and 14 each recite a "**seal extending between**" the claimed housing and plate. I understand that the Court construed the term "**seal**" as "**a component that fills a gap to prevent leakage through the gap**." (Dkt. No. 149.) Dr. Tuckerman interprets the term "**seal**" using Asetek's rejected claim construction position limiting the term to its function, stating "[t]he housing and the plate of the *Antarctica* fluid heat exchanger are continuous/monolithic, and thus sealed." (*See, e.g.*, Tuckerman Op. Rep., Ex. A, Chart I, p. 5.) Dr. Tuckerman's opinion limits the term "**seal**" to a function, but the Court's construction requires both structure *and* function. Nowhere does *Antarctica* include a "**component that fills a gap**" between any housing and plate that prevents leakage through said gap.

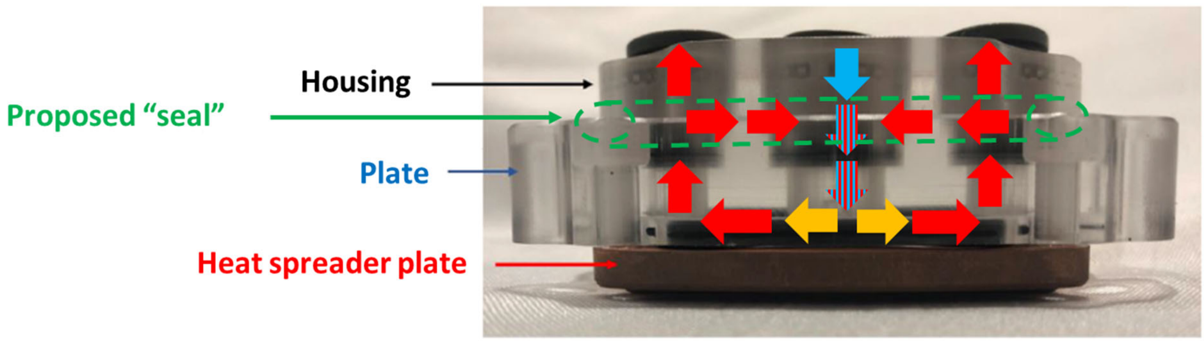
93. Dr. Tuckerman admits that *Antarctica* lacks a "**seal**" by acknowledging that "the housing and the plate of the *Antarctica* fluid heat exchanger comprise a continuous/monolithic structure, so a separate gasket or O-ring between the housing and the plate are not needed to create a fluid-tight contact between them." (Tuckerman Op. Rep., ¶65; *see also, e.g.*, *id.*, Ex. A, Chart I, p. 5.) I agree that a

separate gasket or O-ring is unnecessary for *Antarctica* to function as intended within the calibrated WaterChill liquid cooling system.

94. Although unnecessary, Dr. Tuckerman nevertheless proposes modifying *Antarctica* to separate the regions of the continuous/monolithic plastic structure he identifies as the "**housing**" and "**plate**" and inserting an O-ring in between these two pieces. (Tuckerman Op. Rep., ¶¶66, 70, 72.) As an initial matter, I note that separating the housing from the plate would have the undesired effect of increasing the number of fluidic interconnections and leakage risks within *Antarctica*. However, a POSITA seeking to improve a fluid heat exchanger would have sought to minimize leakage risks—a critical design consideration in liquid cooling systems—by reducing the number of interconnections within the fluid heat exchanger. Dr. Tuckerman recognizes this design consideration in his analysis at paragraph 145, and yet he argues for a modification having the opposite effect.

95. In any event, Dr. Tuckerman's proposed modifications would render *Antarctica* wholly inoperable. Dr. Tuckerman suggests that one could insert an O-ring between a separate housing and plate similar to the one inlaid at the bottom of its continuous/monolithic structure and that doing so "would have been an obvious design choice." (Tuckerman Op. Rep., ¶70.) However, Dr. Tuckerman's proposal is not so trivial and would require additional modifications to *Antarctica* to render it

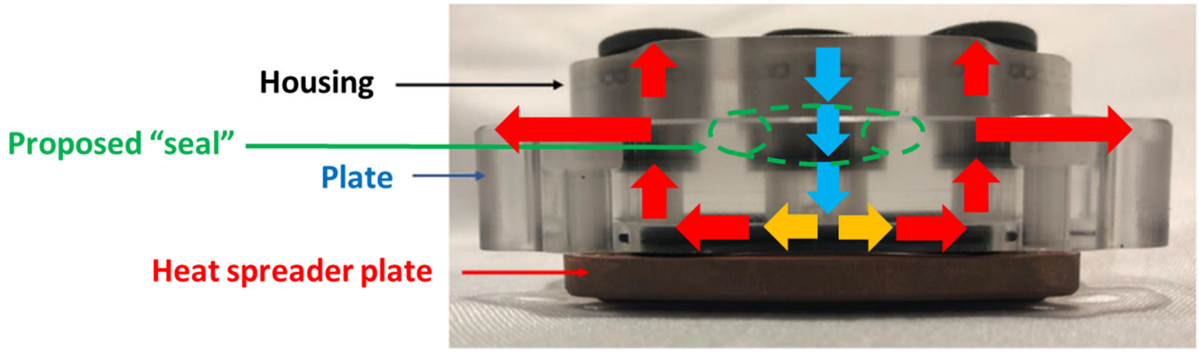
operable. In particular, he fails to consider that O-rings are three-dimensional structures with a height. Without further modifications, introducing an O-ring between Dr. Tuckerman's mapped "**housing**" and "**plate**" regions would cause heated coolant to bypass the outlet passages at the junction between the housing and plate and flow back into *Antarctica*'s channel array via the plate's inlet aperture:



Introduction of heated coolant back into *Antarctica*'s channel array would result in significant loss of thermal heat transfer performance in the device, rendering it inoperable for its intended purpose. Dr. Tuckerman identifies no further modifications that a POSITA would have had to make beyond inserting this O-ring.

96. Dr. Tuckerman also suggests that "it would have been obvious to provide a seal around the elongate inlet opening/aperture in the plate of a modified *Antarctica*, similar to the configuration in *Danger Den-RBX*." (Tuckerman Op. Rep., ¶70.) I presume that Dr. Tuckerman refers to placing this seal at the gap between the housing and the plate, which would also render *Antarctica* inoperable without further

(unmentioned) modifications. In this second proposal, inserting the O-ring around the inlet passage at the junction between the housing and plate regions would result in leakage at the outlet passages due to the height dimension of the O-ring:



97. If Dr. Tuckerman argues that a POSITA would have known to machine a groove into either the "**housing**" or "**plate**" to accommodate his proposed O-ring, *Antarctica* would still fail to satisfy the "**housing spaced from the plate**" limitation in claims 1, 12, and 14 because, outside of the surface where the O-ring contacts either the housing and/or plate, the remaining surfaces of the housing and plate would not be "**spaced apart**"—they would physically touch and/or abut.

98. Setting aside these deficiencies, Dr. Tuckerman also claims that "having the housing and the plate as separate components that are sealed would have been an obvious modification of the *Antarctica* device" and reasons that a POSITA would have been motivated to modify *Antarctica* because "[h]aving [*sic*] separate housing and plate provides greater flexibility in material choice for the housing and the plate,

simplifies manufacturing and assembly of the fluid heat exchanger, and allows for better manufacturing scalability." (*E.g.*, Tuckerman Op. Rep., Ex. A, Chart I, pp. 5-6.) It is unclear to me why Asetek did not implement this modification in *Antarctica* from 2004 to 2007 if it were as obvious as Dr. Tuckerman suggests. In any event, Dr. Tuckerman's purported motivations for modifying *Antarctica* are unsupported and the product of hindsight.

99. Dr. Tuckerman's proposed modifications would not simplify the manufacturing process and reduce costs while improving scalability. While I agree that *Antarctica*'s continuous/monolithic plastic structure was the product of CNC machining, this fabrication method is typically applied in prototyping and suggests that *Antarctica* was a low-volume product. Dr. Tuckerman points to no evidence suggesting heightened consumer demand for *Antarctica* that would have motivated a POSITA to seek alternate manufacturing practices that enable mass production at reasonable costs. On the contrary, Asetek produced *Antarctica* sales information in this litigation showing little demand existed for its product. (*See* ASE-CLT0045045 (590 units sold between February 9, 2004 and November 21, 2006).)

100. But even if a POSITA sought to mass produce *Antarctica*, it would have been simpler and more cost-effective to create an injection mold of *Antarctica*'s continuous/monolithic plastic structure than redesign the device to include a separate

housing and plate with a seal inserted therebetween. Injection molding was well-known in 2007, and a POSITA could have used *Antarctica*'s existing design to create the mold, incurring primarily added tooling costs. In contrast, implementing Dr. Tuckerman's proposed modifications would have increased both manufacturing costs and complexity. Implementation would incur parts and labor costs to redesign, prototype, and test *Antarctica* to include multiple components, tooling charges, and continuing labor costs for assembly of these separate components. Use of multiple components, as opposed to a single mold, introduces additional complexity related to sourcing multiple materials for use in different components, machining each component (as opposed to a single component), and assembly.

101. Dr. Tuckerman also mentions that "[m]aking the housing and the plate separately would also allow the housing and the plate to [*sic*] made of different materials" and then cites to metal plates and housing consisting "of a cost-effective material such as plastic" to reduce manufacturing costs. (Tuckerman Op. Rep., ¶66.) This is pure hindsight reasoning. Dr. Tuckerman provides no reason why a POSITA would have wanted and/or needed to use different materials for these components in *Antarctica*'s design. Moreover, Dr. Tuckerman cites as an advantage using a "cost-effective material such as plastic" for housing when unmodified *Antarctica*'s continuous/monolithic structure is already made from plastic. By Dr. Tuckerman's

own reasoning, the materials costs for a metal plate-plastic housing combination would have been more expensive than the costs for a single plastic mold.

102. Ultimately, Dr. Tuckerman offers no evidence showing that Asetek even attempted to redesign *Antarctica* for mass production, suggesting that the company could not even justify tooling costs in light of small consumer demand. Similarly, the circumstances surrounding *Antarctica*'s lack of commercial success would have deterred a POSITA from seeking out alternate manufacturing processes for mass production (even injection molding).

103. Dr. Tuckerman suggests an additional motivation, namely that "if there is a change in the configuration of the processor to be cooled (and resulting change in the heat spreader plate configuration)," that "only the plate configuration needs to be revised to correspond to the changes in the heat spreader plate." (Tuckerman Op. Rep., ¶66.) Again, he provides no support for this proposition. While his premise may be theoretically possible, most processors have similar configurations such that the thermal interface between the heat source and heat spreader plate would not be appreciable enough to justify a redesign of the plate. In addition, *Antarctica*'s design is such that the inlet and outlet passages in the housing line up directly with that of the plate. A theoretical change in the configuration of the heat spreader plate would likewise change the configuration of the channel array within the heat spreader plate.

The "**housing**" in a modified *Antarctica* would almost certainly have to be adjusted to align with adjustments made to the "**plate**," obviating the very advantage that Dr. Tuckerman recites.

104. Dr. Tuckerman also cites to *Chang*, 6:22-30 to suggest that having a separate housing may be desirable because a POSITA could "modify the configuration of the tubing and/or manner of connection of tubing to the microchannel assembly" without changing the plate or heat spreader plate. (Tuckerman Op. Rep., ¶66.) Again, while that *may* be true, I note that the cited passage refers to *Chang*'s FIG. 4 embodiment where tubing ran through the manifold plate and made a sharp near ninety-degree angle into the cover plate and microchannel structure. *Antarctica*'s vertical tubing and port configuration accounts for motherboard keepouts and tight clearance, as the cooler was designed to be retrofit to existing motherboards where such cooling systems were not factored into the design cycle. It is inherently different than *Chang*. A POSITA would not have been persuaded that *Chang*'s cited advantage would be applicable in view of *Antarctica*'s specific design

considerations, particularly when the same advantages might be achieved using the flexible tubing and Y-fitting also included in the WaterChill liquid cooling system.[11]

105. Dr. Tuckerman also points to the *Danger Den-RBX* device to suggest that a POSITA in 2007 would have known "that the principle of operation of the *Antarctica* can be implemented with separate plate and housing components that are connected together to form the fluid heat exchanger." (*Id*., ¶67; *see also id*., ¶¶68-69 (mapping elements of the '330 patent claims to aspects of the *Danger Den-RBX* device).) As a threshold matter, I understand that Asetek never disclosed *Danger Den-RBX* in its invalidity contentions nor in its final elected of asserted prior art in accordance with limits set by the Court.[12] Regardless, *Danger Den-RBX*'s

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[11] I also note that the WaterChill liquid cooling system also included a large pump and radiator, and the overall system would have required significant space within a computer cabinet to accommodate these parts. (*See, e.g.,* ASE_CLT00044721.) A POSITA would not necessarily have considered port and passage reconfiguration to be particularly advantageous when considering the implementation environment.

[12] To the extent Dr. Tuckerman is permitted to advance opinions on *Danger Den-RBX* as a ground reference against the asserted claims of the '330 patent (or any of

configuration is fundamentally different than *Antarctica*. *Antarctica*'s channels are disposed within the heat spreader plate in parallel with large hydraulic diameters such that pressure drop is low enough that use of a separate seal at the inlet aperture of the plastic structure is unnecessary to prevent fluid bypass. *Danger Den-RBX*'s channels[13] are disposed between fins formed on its heat spreader plate in a zig-zag

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the Asserted CoolIT Patents), I reserve my right to respond in a supplemental report. Preliminarily, I observe that Danger Den-RBX lacks at least the claimed "**microchannels**" (*see infra,* note 13).)

[13] At my June 25, 2021 inspection Asetek belatedly made available a previously undisclosed *Danger Den-RBX* sample. In addition to inspecting *Antarctica*, I also inspected the *Danger Den-RBX* sample and took measurements of its channel widths using electronic vernier calipers. *Danger Den-RBX*'s channel widths are approximately 1.7 mm according to my measurements. (*See* COOLIT0017072, COOLIT0017110, COOLIT0017133, COOLIT0017138, COOLIT0017150.) Dr. Tuckerman does not dispute that *Danger Den-RBX* lacks "**microchannels**" per the '330 patent claims and the parties' stipulated construction. (*See* Tuckerman Op. Rep., ¶69.) However, Dr. Tuckerman opines that "it would have been obvious to

pattern that results in a high pressure drop. This configuration is radically different than *Antarctica* and requires a separate seal at the plate.

106. For all of these reasons, it is my opinion that Dr. Tuckerman has not shown that a POSITA would have been motivated to modify *Antarctica* to include a separate plate and housing with a seal inserted between them. In addition, Dr. Tuckerman's proposed modifications are incomplete and would render *Antarctica* inoperable for its intended purpose.

B. Dr. Tuckerman Fails to Show that Claims 1, 12, and 14 of the '330 Patent Are Rendered Obvious by *Antarctica* in View of *Chang*

107. Dr. Tuckerman offers a second ground to challenge the asserted claims of the '330 patent based on a combination of *Antarctica* in view of *Chang*. Dr. Tuckerman's mapping of *Antarctica* is consistent with his first ground and thus suffers the same infirmities that I discussed in my analysis in Section VIII.A, fully

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replace the mini-channels … in the Danger Den-RBX with microchannels," but he merely rehashes the same reasons he raised earlier with respect to *Antarctica*. (*Compare id.*, ¶57 *with id.*, ¶69.) The analysis I provided in Section VIII.A.1 explaining why a POSITA would not implement "**microchannels**" in *Antarctica* also applies to *Danger Den-RBX*.

incorporated here, with respect to the following limitations in claims 1, 12, and 14: "**microchannels**," "**plate**," "**housing spaced apart from the plate**," "**wherein the outlet [defined by the housing] [aperture] opens from [an / the] outlet header [region]**," and "**seal extending between the [housing / plate] and the [[apertured] plate / housing]**." In his second ground, Dr. Tuckerman simply adds *Chang* in an attempt to bolster his position that a POSITA would have been motivated to modify *Antarctica* "to have a separate housing and plate and a seal therebetween because of the manufacturing advantages and cost-effectiveness of having [*sic*] separate housing and plate." (Tuckerman Op. Rep., ¶74.) He still cites the same purported advantages—simplified manufacturing, flexibility in housing/plate materials, and improved scalability—that I addressed in my Section VIII.A.4 analysis, also incorporated here.

108. I also disagree with Dr. Tuckerman's claim that a POSITA would have been motivated to modify *Antarctica* to include a seal between separate housing and plate by looking to *Chang*'s FIG. 4 embodiment or *Danger Den-RBX*. (*See* Tuckerman Op. Rep., ¶77.) *Chang*'s microchannels, at 0.05-.15 mm (*see* Chang, 4:28-32), are significantly smaller than *Antarctica*'s channels and cause a higher pressure drop in the system that requires a separate plate to seal the channels. And, for the reasons I discussed in Section VIII.A.4, *Danger Den-RBX*'s heat spreader plate is

fundamentally different than in *Antarctica* and also requires a seal and separate plate to compensate for the high pressure drop imposed by the zig-zag pattern of its fins. A POSITA would not have considered a seal or separate plate to be necessary in *Antarctica* through review of these systems. Finally, I note that *Antarctica* would not function as intended if a POSITA implemented Dr. Tuckerman's proposed modifications for the reasons I discussed in Section VIII.A.4, fully incorporated here. It is therefore my opinion that Dr. Tuckerman has failed to show that a POSITA would have modified *Antarctica* in view of *Chang* or had a reasonable expectation of success in doing so.

109. While Dr. Tuckerman appears to rely on *Chang* in his proposed combination for the motivation to modify *Antarctica* to include a separate housing and plate with a seal sandwiched therebetween (*see* Tuckerman Op. Rep., ¶¶74-77), he also posits that "*Chang* discloses every limitation of the asserted claims, including a seal extending between the housing and the plate." (*Id*., ¶73.) I understand that Asetek previously challenged all claims of the '330 patent in IPR2015-01276 and the PTAB affirmed the patentability of claims 1, 4, 12, 14, and 15 (among others) over Asetek's challenge. (*See generally* COOLIT0024187-COOLIT24252 (Asetek's Petition); COOLIT0025454-COOLIT0025447 (Final Written Decision).) I also understand that under the patent laws Asetek is estopped from raising any invalidity ground that

it raised or could reasonably have raised during the prior IPR—in other words, patents and printed publications.

110. I am aware that Asetek's invalidity contentions originally included a ground that the asserted claims of the '330 patent were anticipated and/or obvious in view of *Chang*, and that CoolIT moved to strike this ground (and others) based on IPR estoppel. (*See* Dkt. Nos. 53, 61.) I understand that the Court agreed with CoolIT and struck these *Chang*-based grounds from Asetek's invalidity contentions. (*See* Dkt. No. 98.)

111. In light of Dr. Tuckerman's limited reliance on *Chang*, and the fact that Asetek is estopped from relying primarily on *Chang*, I have not provided a complete opinion on whether *Chang* discloses each and every limitation in the asserted claims of the '330 patent. It does not for at least the exemplary reasons I highlight in Section VII.B above. However, should Dr. Tuckerman shift his reliance on *Chang* beyond the narrowly-defined opinion at paragraphs 74-77 of his opening report, I reserve my right to respond to any new allegations in a supplemental report.

IX. OPINIONS REGARDING U.S. 9,603,284

A. Dr. Tuckerman Fails to Show that a POSITA Would Have Considered the Asserted Claims to be Indefinite

112. Claims 1 and 15 would have reasonably informed a POSITA about the scope of claimed fluid heat exchangers. Contrary to Dr. Tuckerman's indefiniteness

allegations, a POSITA would *clearly* have understood and appreciated that the recitation "outlet flow path" refers to a path that coolant follows from the outlet of each microchannel to the outlet port from the claimed fluid heat exchanger.

113. The term "flow path" or "pathline"—the path flow takes through space as a function of time—was well-understood in the art, often appearing in introductory, undergraduate courses on fluid mechanics. (*See, e.g.,* Ex. D (2008 MIT fluid mechanics lecture notes).) The '284 patent's description of flow paths is consistent with this fundamental fluid concept. The specification describes three segments of flow through a claimed heat exchanger: a fluid inlet passage **104**, a fluid outlet passage **106**, and microchannel flow passages **103** that receive fluid from the inlet passage and convey it to the outlet passage. ('284, 2:54-60 (describing all three segments); FIGs. 1-3 (inlet passage **104** and outlet passage **106**); *see also id.*, 4:11-15, 6:64-67 (describing inlet passage **104**); *id.*, 2:54-60, 5:13-20, (describing outlet passage **106**).) Annotated FIG. 1 shows inlet passage **104** (**blue**) and outlet passage **106** (**red**):

HIGHLY CONFIDENTIAL – ATTORNEYS' EYES ONLY

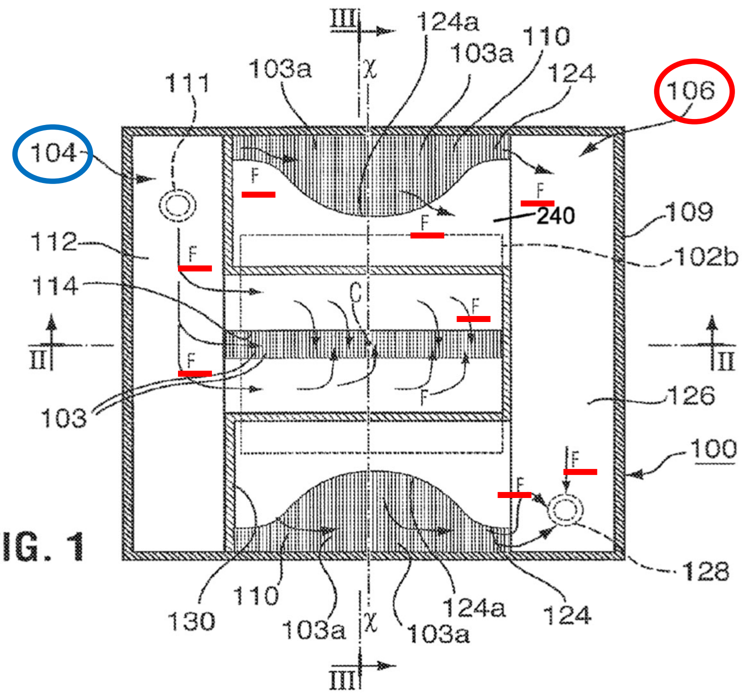


FIG. 1

('284, FIG. 1 (annotated).) The'284 patent also describes and illustrates the "path" that fluid follows as it passes through the heat exchanger, and the terminal boundaries of each segment, with reference to "arrows F":

> Heat exchanging fluid, as shown by <u>arrows F</u> [**red underline**], enters the fluid heat exchanger through port **111**, passes into the header **112** and through opening **114**. The heat exchanging fluid then passes down between walls **110** into channels **103**, where the fluid accepts thermal energy from the walls **110** and surface **102*a***. The heat exchanging fluid, after passing down into the channels, then impinges against surface **102*a*** to be diverted toward ends **103*a*** of the channels toward outlet openings **124**. In so doing, in the illustrated embodiment, the fluid is generally split into two subflows moving away from each other and away from inlet **114** toward openings **124** at the ends of the

> microchannels. Fluid passing through channels becomes heated, especially when passing over the region in direct contact with the heat source, such as, in the illustrated embodiment, the central region of the heat spreader plate. Heated fluid passes out of openings **124**, into header and thereafter through port **128**. The heated fluid will circulate through a heat sink where its thermal energy is unloaded before circulating back to port **111**.

('284, 6:28-47 (annotations and emphasis added).)

114. The '284 patent explains that "fluid inlet passage **104** … in the illustrated embodiment includes a port **111** through the housing opening to a header **112** and thereafter a fluid inlet opening **114** to the microporous fluid channels **103**." ('284, 4:11-15.). A POSITA would have understood that the fluid inlet passage of the illustrative fluid heat exchanger extends from the inlet port to the opening to each microchannel. The specification teaches that flow through the channel segment extends from inlet **114** to outlet openings **124** at opposed ends of the microchannels.

115. Similarly, the '284 patent explains that "fluid outlet passage **106** … in the illustrated embodiment includes one or more fluid outlet openings **124** from the microporous fluid channels **103**, a header **126** and an outlet port **128** [that opens] from the housing." ('284, 5:13-17.) A POSITA would also have understood that the fluid outlet passage of the illustrative fluid heat exchanger extends from the outlet

opening from each microchannel to the outlet port. It is through this passage that fluid flows—*i.e.*, it is a "flow path."

116. Throughout its description, the '284 patent actually uses the term "path" to describe the movement of fluid through the fluid heat exchanger. ('284, Abstract ("Each microchannel can define a continuous channel flow path between its respective first end and opposite end."); 1:31-51 (each microchannel has a continuous channel flow path between its first end and opposite end); 1:52-2:12 (same; describing further a flow of heat exchanging fluid entering the microchannels between the first ends of the microchannel[s] and diverting the flow into a plurality of subflows that each flow away from the other); 3:16-32 ("the channel area, defined between upper surface **102*a*** and the microchannels walls **110**, channels or directs fluid to create a fluid flow path. The channel area may be open or filled with thermally conductive porous material such as metal or silicon foam, sintered metal, etc. Thermally conductive, porous materials allow flows through the channels but create a tortuous flow path."); 3:44-51 ("Facing microchannel walls **110** may be configured in a parallel configuration, as shown, or may be formed otherwise, provided fluid can flow between the microchannel walls **110** along a fluid path."). Review of the specification would have reasonably informed a POSITA that the term "flow path" refers to the path that a fluid follows as it passes along a given segment

of a passage through the heat exchanger. Accordingly, the written description and drawings inform a POSITA that (1) a claimed "inlet flow path to each respective microchannel" refers to the path that the fluid follows as it flows from the inlet port into each microchannel; and (2) a claimed "outlet flow path" refers to the path that the fluid follows as it flows along the outlet passage from its beginning to its end.

117. Discussion of flow paths also arose during prosecution of the '284 patent, where the applicant observed:

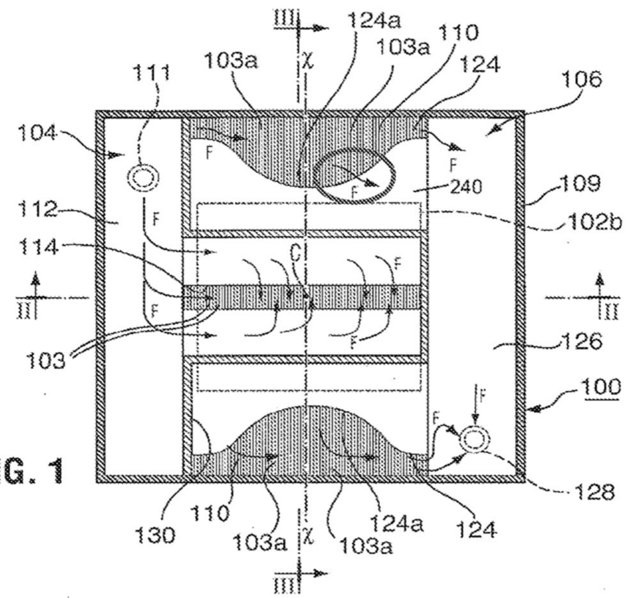


FIG. 1

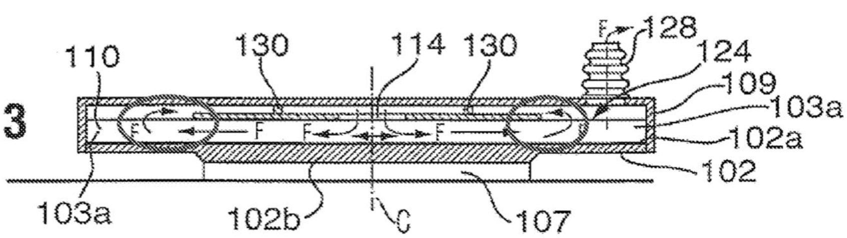


FIG. 3

As explained in the excerpted passage above, the arrows F indicate a flow path of the fluid described as passing out of the openings 124 and into the outlet header 126. The portions of the outlet header 126 receiving the flow indicated by the circled arrows clearly extend over the plate defining the elongate aperture 114.

In summary, the specification explains that the heated fluid passes out of the openings 124 and into the outlet header 126. FIGS. 1 and 3 show a flow of the heated fluid passing into a portion of the outlet header 126 extending over the plate. The plate defines the elongate opening

(*See* COOLIT001597 (July 14, 2015 Applicant Amendment, p.13).) Afterward, the Examiner expressly considered "the allowable subject matter of the differing flow path lengths of a central or center microchannel relative to endmost or outermost

microchannels." (*See* COOLIT001726 (January 5, 2017 Examiner-Initiated Interview Summary).)

118. The claims themselves provide sufficient particularity for a POSITA to have understood what "outlet flow path" meant with reasonably certainty. Claim 1 specifies that each outlet flow path corresponds to an "outlet opening in fluid communication with each of the microchannel first ends." ('284, 7:66-8:1.) Each outlet flow path begins at the end of each microchannel. Claim 1 further specifies that "the outlet port [of the housing] is in fluid communication with each respective outlet flow path from the microchannel first ends." (*Id.*, 8:19-21.) A POSITA reviewing the plain language of the claims would have understood with reasonable certainty that an outlet flow path from a given microchannel begins at the microchannel's first end and ends at the outlet port, following the fluid as it flows (along the discussed outlet flow passage) between those terminal ends. The arrows F in annotated FIG. 1 above illustrate exemplary outlet flow paths.

119. Claim 15 provides similar particularity as claim 1, reciting that an outlet flow path corresponds to each microchannel. ('284, 9:27-32.) The "outlet flow path [is] positioned outward of the plate and extend[s] from [each] respective microchannel adjacent the … first end [of that microchannel]." (*Id.*) The claim emphasizes that its fluid heat exchanger has an outlet flow path from each opposed end of each

microchannel. (*Id.*, 9:43-45.) The claim makes clear that the outlet flow path begins adjacent each microchannel first end. Claim 15 also recites that its housing has an outlet port. (*Id.*, 9:40.) A POSITA would have understood and appreciated that fluid exhausts from the claimed fluid heat exchanger through the outlet port, and would have naturally inferred that an outlet flow path from a given microchannel begins at the microchannel's first end and ends at the outlet port, following the fluid as it flows between those terminal ends (along the discussed outlet flow passage) —similar to the "outlet flow path" recited in claim 1. Nothing about the "outlet flow path" in claim 15 would appear indefinite or unclear to a POSITA.

120. Claims 1 and 15 also recite "the outlet flow path from a centrally located first end … is larger than the outlet flow path from another [microchannel] first end …." (284, 8:7-11, 9:55-58.) A POSITA would still have understood the "outlet flow path" described therein with reasonable certainty. FIG. 1 provides a clear example, denoting an outlet flow path from a central microchannel (**red arrow**) that is larger than (*e.g.*, longer than) an outlet flow path from an outer microchannel (**blue arrow**):

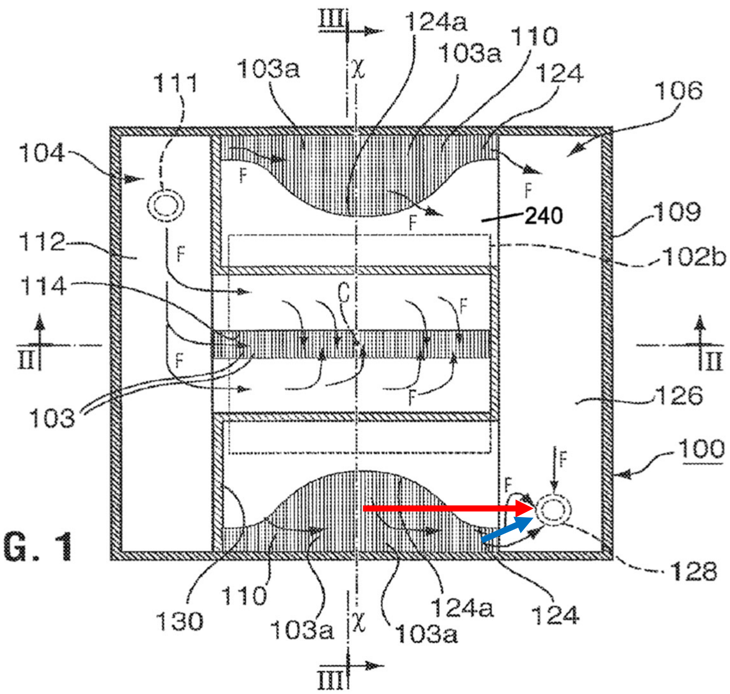


FIG. 1

(*Id*., FIG. 1 (annotated).)

121. Dr. Tuckerman incorrectly asserts that determining a given product's infringement "depend[s] on where the end of the 'outlet flow path' is chosen to be," rendering claims 1 and 15 indefinite. (Tuckerman Op. Rep., ¶110.) But Dr. Tuckerman improperly assumes indefiniteness by contending that a POSITA would be left to arbitrarily choose where each outlet flow path ends. He is incorrect. As explained above, a POSITA would have understood in reviewing the '284 patent specification and claims that each outlet flow path ends at the outlet port.

122. Dr. Tuckerman also asserts that claims 1 and 15 are indefinite because "it would not be reasonably possible to determine the precise outlet flow path of fluid

after it exits the microchannels." (Tuckerman Op. Rep., ¶112.) While I agree that fluid from one microchannel will mix with fluid from another microchannel within the outlet header, this phenomenon would not render claims 1 and 15 uncertain or unclear to a POSITA. For example, flow through a long hose can be turbulent and flow through a short hose can be turbulent. Nevertheless, a POSITA would not have taken the absurd position that he could not with reasonable certainty determine whether the flow path through the long hose is longer than a flow path through the short hose.

123. Rather, a POSITA would have modeled fluids as continuous media (although fluids are known to comprise individual particles) and consider bulk flows of fluids through devices, such as those described in claims 1 and 15. Thus, despite mixing and turbulence within a stream of fluid, a POSITA would have considered bulk or average paths of the fluid through the device when comparing an outlet flow path from a central microchannel to an outlet flow path from an outer microchannel. Contrary to Dr. Tuckerman's position, it is my opinion that the specification and the claims reasonably inform a POSITA where each outlet flow path begins and ends.

124. The inventor of the '284 patent, Mr. Geoff Lyon, agrees:

> Q: So can you – once the liquid is in the outlet header and this mass flow of liquid toward the outlet port, can you tell a flow length

of an outlet port from a centrally located microchannel versus the flow length of the outlet path from the outer microchannels?

A: Well, they're different physical distances from the outlet.

Q: But all of the liquid in the header is mixed in, right?

A: It doesn't matter. Still, the liquid that comes out of that channel is going to travel further than the one next to it.

Q: But how can you tell what liquid is traveling further?

A: The liquid that comes from the channel that's the further away would have to travel the furthest to get out the outlet port.

(Lyon Dep. Tr. (Feb. 11, 2021), 100:9-101:1.) Mr. Lyon also testified that, as common sense would dictate, outlet flow paths differ among different embodiments. (*Id.*, 108:2-5.)

125. Different embodiments are indeed different embodiments. Even assuming that one embodiment or accused product implements (or embodies) an outlet flow path in a manner different from how another embodiment or accused product implements an outlet flow path, the '284 patent's claims and specification would have still informed, with reasonable certainty, a POSITA's understanding that an outlet flow path refers to the path fluid follows as it flows from a microchannel end to the housing's outlet port. Mr. Lyon agrees. (Lyon Dep. Tr. (Feb. 11, 2021), 99:19-101:15.)

B. Dr. Tuckerman Fails to Show that the Asserted Claims Lack Written Description Support

126. At the outset, I agree with Dr. Tuckerman that the phrase "outlet flow path" does not appear word-for-word in the specification. I also agree that "an 'outlet opening' is different from an 'outlet flow path.'" (Tuckerman Op. Rep., ¶107.) But I disagree with Dr. Tuckerman's conclusion that, because of that distinction, a POSITA reviewing the '284 patent would not have understood the inventor to be in possession of the "outlet flow paths" recited in claims 1 and 15.

127. I have already examined the intrinsic support for "outlet flow path" in Section IX.A above, which I fully incorporate here. To summarize, the '284 patent describes a fluid outlet passage **106** as one of three flow segments through a fluid heat exchanger. (*See* '284, 2:54-60 (separately identifying a fluid inlet passage **104**, a fluid outlet passage **106**, and microchannel flow passages **103**).) The patent expressly identifies that fluid outlet passage **106** in an illustrated embodiment "includes one or more fluid outlet openings **124** from the microporous fluid channels **103**, a header **126** and an outlet port **128** opening from the housing." (*Id.*, 5:13-20.) As I previously discussed, a "flow path" refers to the path a fluid travels through space as a function of time. (*See* Ex. D.) The '284 patent provides numerous examples describing the "path" that fluid follows as it passes through the heat exchanger. (*See, e.g.*,'284, 6:28-45 ("Heat exchanging fluid, <u>as shown by arrows F</u>,

enters the fluid heat exchanger through port **111**, passes into the header **112** and through opening **114**."); FIGs. 1, 3 (showing fluid, indicated by arrows F, exiting the microchannels and passing through the outlet passage from the microchannels to the outlet port); COOLIT001597 (July 14, 2015 Applicant Amendment, p.13) ("As explained in the excerpted passage above, <u>the arrows F indicate a flow path of the fluid</u> described as passing out of the openings 124 and into the outlet header 126.").) And, as I noted earlier, a POSITA would have understood with reasonable certainty based on these disclosures that the "outlet flow path" recited in claims 1 and 15 refers to a path that coolant follows as it flows from an end of each microchannel to the outlet port of the housing in the claimed fluid heat exchanger.

128. The '284 patent's prosecution history further confirms that "outlet flow path" has written description support. I am informed by counsel that 37 C.F.R. § 1.75(d)(1) requires that a claim must conform to a description of the invention as set forth in the remainder of the specification, and that terms and phrases used in the claims must find clear support in the description so that the meaning of claim terms may be ascertained by reference to the description. According to his summary of the January 5, 2017 Examiner-initiated interview, the Examiner appears to have determined that the relative sizes of the outlet flow paths recited in the claims had clear support in the written description such that the meaning of these claim terms

may be ascertained. (*See* COOLIT001726 (January 5, 2017 Examiner-Initiated Interview Summary).) For the foregoing reasons, I agree with the Examiner.

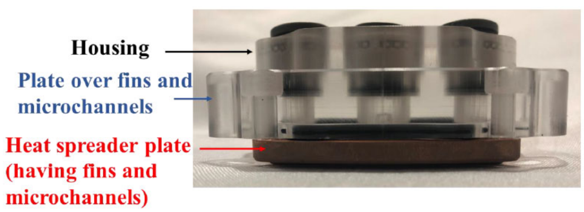
C. Dr. Tuckerman Fails to Show How the Asserted Claims of the '284 Patent Are Rendered Obvious by *Antarctica*

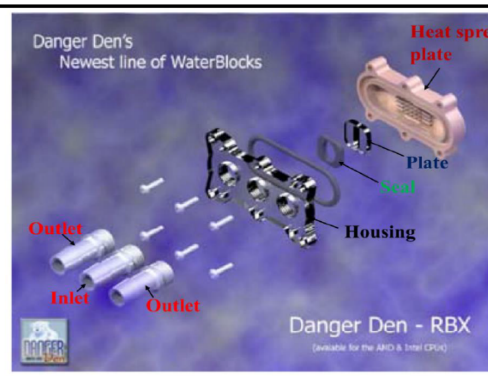
129. Claims 1 and 15 of the '284 Patent recite the same "**microchannels**," "**plate**," "**housing positioned over and spaced apart from the plate**," and "**seal**" limitations also present in claims 1, 12, and 14 of the '330 Patent. *Antarctica* does not disclose these limitations in the asserted claims of the '284 Patent for the same reasons I provided in my Section VIII.A analysis above, which I fully incorporate here.

130. Dr. Tuckerman also argues, with respect to claims 4 and 19 (on which claims 5 and 20 depend), that a separate housing in a modified *Antarctica* would have to contact with either the plate alone (which in turn contacts and connects with the spreader plate." (Tuckerman Op. Rep., Ex. B, Chart 1, pp. 8, 17.) In other words, Dr. Tuckerman takes the position that indirect contact, through an intervening structure, satisfies the limitation "**the housing contacts the spreader plate**." A POSITA would not have considered two structures that do not physically touch to satisfy this limitation for the reasons I discuss for *Hamilton*, *infra.* Section IX.F.4.

131. In the alternative, Dr. Tuckerman baldly asserts that it would have been obvious to a POSITA that "to form an integrate fluid heat exchanger where the primary components (housing, plate, and heat spreader plate) are held together, …

the housing would have to contact and connect directly with the heat spreader plate." (*Id.*) Dr. Tuckerman points to *Danger Den-RBX* as an example but, *Danger Den-RBX*'s housing/plate configuration differs dramatically from the housing/plate configuration present within Dr. Tuckerman's modified *Antarctica* proposal:





Exploded view of the Danger Den – RBX.

(*Compare* Tuckerman Op. Rep., ¶55, *with id.*, ¶¶68-69.) Whereas modified *Antarctica* is a stacked housing/plate configuration where the "plate" extends far beyond the dimensions of the "housing," *Danger Den-RBX* includes a much smaller "plate" that appears to sit within a recess of the "spreader plate" to permit contact between the "spreader plate" and "housing."

132. Visual comparison of these two devices makes abundantly clear that a POSITA would have had to make far more than trivial and/or routine modifications in *Antarctica* to arrive at this claim limitation. With classic hindsight reasoning, Dr. Tuckerman makes conclusory assertions of "design choice" and "obvious design alternative" but fails to provide any explanation for (1) how a POSITA would

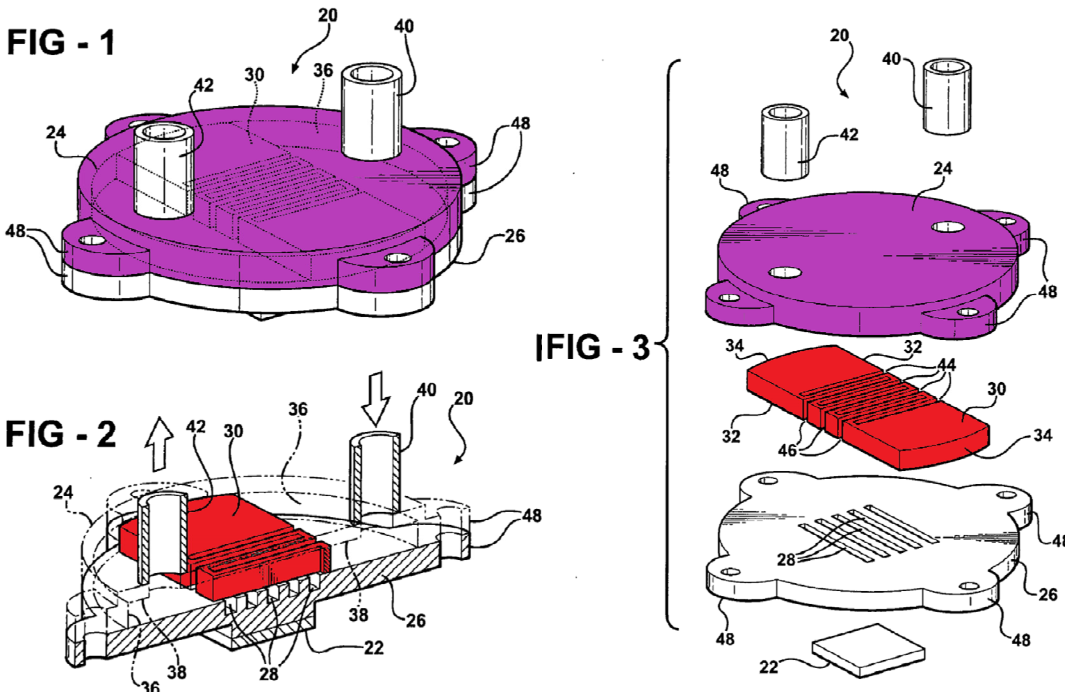
modify *Antarctica* to permit the housing and plate to touch, or (2) that individual would necessarily be motivated to do so.

133. For these reasons, it is my opinion that Dr. Tuckerman has not shown that *Antarctica* renders obvious any of the asserted claims of the '284 patent.

D. Dr. Tuckerman Fails to Show How the Asserted Claims of the '284 Patent Are Anticipated or Rendered Obvious by *Bhatti*

1. *Bhatti* lacks a "housing positioned over and spaced apart from the plate" (Claims 1, 15)

134. Claims 1 and 15 require that the claimed housing be "positioned over and spaced apart from the plate." Dr. Tuckerman identifies *Bhatti*'s lid **24** as the "**housing**" and manifold plate **30** as the "**plate**." (*See* Tuckerman Op. Rep., Ex. B, Chart II, pp. 6, 15.) *Bhatti*'s FIGs. 1-3 show, however, that lid **24** (purple) is not "spaced apart" from manifold plate **30** (red):



(Bhatti, FIGs. 1-3.) Manifold plate **30** is sandwiched between lid **24** and base **26**. *Bhatti* further provides that lid **24** "has a periphery engaging the base and <u>an interior shoulder **36** engaging the ends **34** of the manifold plate **30** to define a recessed surface **38** within the periphery and in engagement with the top face of the manifold plate **30**</u>." (*Id.*, [0017] (underlining added).) A POSITA would have gleaned from this passage that *Bhatti*'s lid **24** is not "**spaced apart**" from manifold plate **30**.

135. Thus, it is my opinion that unmodified *Bhatti* does not anticipate or render obvious this limitation from claims 1 and 15. I cite additional reasons that *Bhatti* does not anticipate or render these claims obvious in my analysis below.

2. *Bhatti* does not disclose "wherein each respective inlet flow path is split generally into two subflow paths, wherein one of

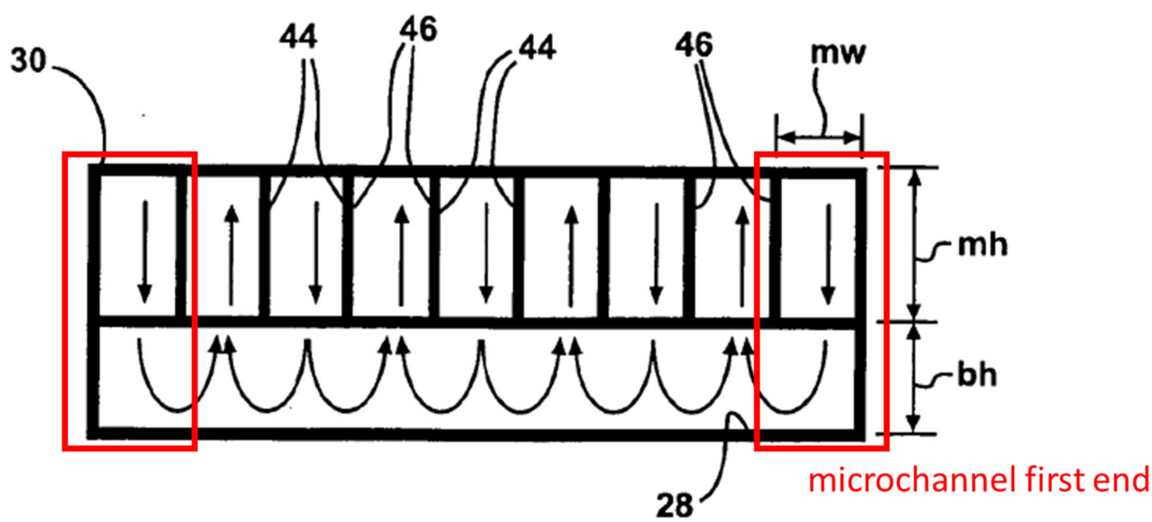
the subflow paths extends outwardly toward the corresponding microchannel first end and passes outwardly of the plate along the outlet flow path from the respective microchannel first end" and a POSITA would have been deterred from eliminating all but one inlet channel and all but two outlet channels in manifold plate 30 (Claims 1, 15[14])

136. Dr. Tuckerman admits that *Bhatti*'s "[m]anifold plate 30 has a plurality of inlet channels 44 and outlet channels 46, which create multiple split-flows through the lengths of the microchannels." (Tuckerman Op. Rep., Ex. B, Chart II, p. 14.) FIG. 5 makes clear that *Bhatti* fails to satisfy that (1) "**each respective inlet flow path is split generally into two subflow paths**" and (2) "**one of the subflow paths extends outwardly toward the corresponding microchannel first end and passes**

[14] I note that claim 15 has a similar limitation, reciting "wherein each respective inlet … splits generally into two subflow paths after entering the corresponding microchannel, wherein one of the two subflow paths extends outwardly toward the corresponding microchannel first end … wherein the subflow path toward the microchannel first end passes from the respective first end along the corresponding outlet flow path." I refer to claim 1's language above, but my analysis applies with equal force to claim 15's analog.

outwardly of the plate along the outlet flow path from the respective microchannel first end":

FIG - 5



(Bhatti, FIG. 5 (annotated).) As shown in the red boxes, at least two inlet flow paths do not split into two subflow paths. In addition, an inlet flow path exists at the microchannel first end, not an outlet flow path.

137. To shore up these deficiencies, Dr. Tuckerman proposes modifying *Bhatti* "to have a single inlet channel 44 at midway along the microchannel lengths and two outlet channels 46 at the ends of the microchannels, … for manufacturing simplicity and cost-effectiveness." (Tuckerman Op. Rep., Ex. B, Chart II, pp. 14-15.) But Dr. Tuckerman's purported rationales, to the extent they are legitimate, are outweighed by the technical advantages conferred by *Bhatti*'s multi-split flow design.

138. In fluid heat exchangers, channels with small hydraulic diameters (*e.g.*, microchannels) increase flow resistance as compared to channels with large hydraulic diameters (*e.g.*, macro-channels) and, accordingly, increase pressure drop as a fluid passes along the length of the channel. However, channels with small hydraulic diameters also substantially increase the available surface area for heat transfer as compared to channels with larger hydraulic diameters.

139. *Bhatti* uses multiple inlets and outlets to generate multiple split-flows, balancing the penalty imposed of increased flow resistance when using channels with small hydraulic diameters with the benefit conferred of increased heat transfer. Specifically, *Bhatti*'s multiple inlets and outlets provide short flow lengths within the channels, from the point fluid enters the channels (inlet manifold channels **44**) to the point it exits from the channels (outlet manifold channels **46**). (Bhatti, [0020], [0021].) Pressure drop from these short flow lengths is comparatively lower than if fluid traveled along a longer flow path through the channels—*e.g.*, Dr. Tuckerman's proposed single split-flow modification to *Bhatti*.

140. *Bhatti*'s multiple split-flow configuration maintains a low overall pressure drop from *Bhatti*'s inlet plenum to its outlet plenum as compared to using a longer flow path through the channels, as the various inlets and outlets described above are fluidly coupled with each other in parallel. At the same time, *Bhatti*'s device

achieves higher overall heat transfer rates from heat source **22** specifically *because* multiple inlet and outlet channels are able to quickly deliver cool fluid into and out of the micro-channels **28**. *Bhatti* specifically cites this increased heat transfer efficiency as a core benefit of its device configuration. (*See* Bhatti, [0006], [0007] ("[T]he subject invention provides a heat sink that maximizes heat transfer <u>by optimizing the operational relationship of the parameters</u> that affect coolant flow and heat transfer.").)

141. A POSITA, weighing the advantages flowing from *Bhatti*'s use of multiple inlet manifold channels **44** and outlet manifold channels **46** (*e.g.*, low pressure drop, enhanced heat transfer), would have had no reason to modify *Bhatti*'s device in the manner Dr. Tuckerman suggests—*i.e.*, eliminating all but a single inlet manifold channel **44** and all but two outlet manifold channels **46**. *Bhatti*'s configuration teaches away from such modifications, which would sacrifice and/or lessen the inherent advantages described above. Reducing manifold plate **30**'s number of outlet channels would likewise reduce the rate that coolant could flow out of *Bhatti*'s micro-channels **28**. Coolant remains in *Bhatti*'s micro-channels **28** under Dr. Tuckerman's proposed modification, causing more fluid preheat and reducing the temperature difference between the micro-channels and coolant. The device's heat transfer rate would significantly decrease because of these modifications, in tension

with *Bhatti*'s express goal of "maximiz[ing] heat transfer by optimizing the operational relationships of the parameters that affect coolant flow and heat transfer." (Bhatti, [0007].)

142. Dr. Tuckerman alleges that a POSITA would have been motivated to modify *Bhatti* "for manufacturing simplicity and cost-effectiveness." (Tuckerman Op. Rep., Ex. B., Chart II, p. 14.) However, Dr. Tuckerman's proposed modifications would lengthen coolant flow paths within *Bhatti*'s micro-channels, resulting in a significant increase to flow resistance (*e.g.*, higher pressure drop) that would require more pumping power to drive coolant through the array than before. A POSITA would need a more powerful—and thus, more costly and possibly less reliable—pump to drive coolant through *Bhatti*'s micro-channels. In fact, I note that the PTAB rejected the very rationales that Dr. Tuckerman now provides when Asetek's expert proposed similar modifications to *Kang*. See *Asetek Danmark A/S v. CoolIT Systems, Inc.*, IPR2020-00825 (Paper 50), at 38-39 (P.T.A.B. Oct. 12, 2021) ("These modifications to the inlet and outlet channels would increase flow resistance through the microchannels, possibly requiring further modifications to the microchannels to increase their hydraulic diameters and/or a higher capacity pump (<u>which would be more expensive</u>). . . For example, [Asetek's expert] does not provide any explanation or evidentiary support for his assertion that modifying Kang in the manner Petitioner

proposes would simplify manufacturing or reduce complexities and costs. . . . This assertion is conclusory and unpersuasive.") (underlining added).

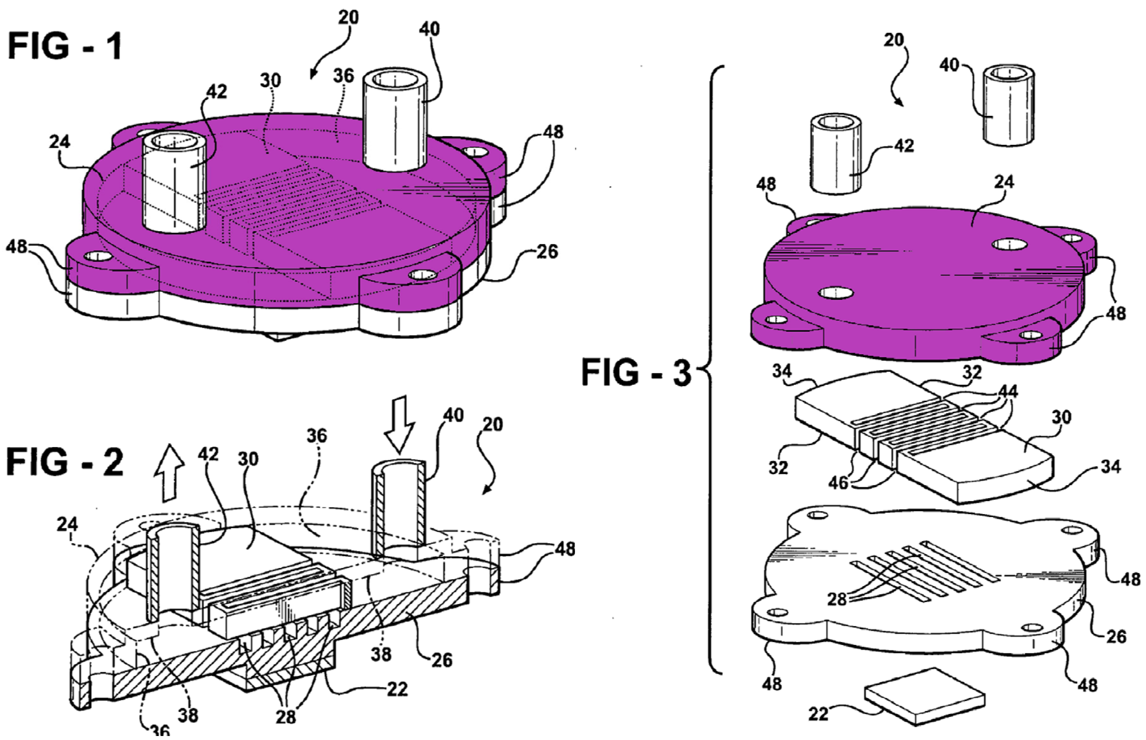
143. In summary, Dr. Tuckerman's proposed modifications to *Bhatti* would reduce heat transfer performance and remove the very advantages its inventors sought to achieve in its unmodified, multiple split-flow design. (*See* Bhatti [0007].) Accordingly, it is my opinion that a POSITA would have been deterred from implementing Dr. Tuckerman's proposed modifications to *Bhatti*.

3. ***Bhatti* lacks "a seal extending between the housing and the plate and separating the inlet flow path to each of the microchannels from the outlet flow path from each of the microchannel first ends, …" (Claims 1, 15)**

144. Claims 1 and 15 include the "**seal**" limitations that I discussed above with respect to Section VIII.A.4. However, *Bhatti*'s heat sink configuration lacks a "**seal**" under the Court's construction—*i.e.*, "**a component that fills a gap to prevent leakage through the gap**."

145. Dr. Tuckerman's mapping points to Bhatti's shoulder **36** as the claimed seal, arguing that it "extends between lid 24 and ends 34 of manifold plate 30. *See Bhatti*, Figs. 1 and 2." (Tuckerman Op. Rep., Ex. B, Chart II, pp. 8, 17.) Dr. Tuckerman neglects that the Court's construction calls for the seal to be a "component," such that the seal is a "component… extending between the housing and the plate." Shoulder **36** is part of lid **24**. Dr. Tuckerman cites FIGs. 1 and 2 in support of his

opinion, but these diagrams depict *Bhatti*'s assembled heat sink configuration and obfuscate whether shoulder **36** is a separate component to the housing (*i.e.*, lid **24**). A POSITA would have examined lid **24** in FIGs. 1 and 2 and compared it with FIG. 3's exploded view of *Bhatti*'s heat sink:



(Bhatti, FIGs. 1-3 (annotated).) FIG. 3 shows that lid **24** is monolithic. Shoulder **36**, rather than a separate component, is part of the depth dimension along lid **24**'s peripheral edge. Bhatti expressly describes this continuous relationship, reciting that "lid **24** has a periphery engaging the base and an interior shoulder **36** engaging the ends **34** of the manifold plate **30**…" (*Id.*, [0017].) Dr. Tuckerman's opinion contradicts *Bhatti*'s clear disclosures, and a POSITA would not have considered

shoulder **36** to be the claimed "**seal**." It cannot be, for it is neither a component, nor does it fill a gap to prevent leakage. It is part of the housing.

146. If, for the sake of argument, I assumed shoulder **36** was separate from lid **24** as Dr. Tuckerman's mapping suggests, *Bhatti* still does not satisfy "**separating the inlet flow path to each of the microchannels from the outlet flow path from each of the microchannel first ends**." Shoulder **36** only engages with ends **34** of manifold plate **30**; the underside of lid **24** (via recessed surface **38)** engages with the top surface of manifold plate **30**. (*See* Bhatti, FIGs. 1-3, [0017].) Thus, it is the seal and the housing, not just the seal, that separates the inlet flow path from the outlet flow path under Dr. Tuckerman's arrangement.

147. Recognizing that shoulder **36** is not a seal, Dr. Tuckerman opines in the alternative that it "would have been obvious to one skilled in the art in August 2007 to provide an O-ring or another gasket between the top face of plate 30 and the underside of lid 24, or between shoulder 36 and the edges 34 of manifold plate 30." (Tuckerman Op. Rep., Ex. B, Chart II, pp. 9-10, 17-18.) I disagree. A POSITA examining Bhatti would not have been motivated to modify its heat sink configuration to include gaskets in the manner that Dr. Tuckerman describes.

148. Dr. Tuckerman asserts that *Bhatti* supports his modification and points to paragraph [0019] as reciting that "[a]ppropriate gaskets are sandwiched between the

matting parts." (*Id*., pp. 9, 18.) This passage has nothing to do with contact between interior shoulder **36**, the underside of lid **24**, and the contours of manifold plate **30**. Rather, *Bhatti* explains:

> The lid **24** and the base are circular in exterior configuration and include ears **48** extending radially for <u>mating engagement</u> and defining bolt holes to receive bolts for sealing the lid **24** to the base with the manifold sandwiched therebetween. Appropriate gaskets are sandwiched <u>between the mating parts</u>.

(Bhatti, [0019].) *Bhatti* is clear that gaskets are appropriate to place between ears **48 (**extending outwards for mating engagement with the bolts) and the peripheral edges of lid **24** and base **26**. This makes sense, as washers and O-rings (*e.g.,* gaskets) are commonly used with bolt holes and bolts to hold two structures together and minimize risk of fluid leaking out of the heat sink.

149. However, POSITA would not have inferred from this common gasketing use with bolt holes and bolts that one would insert gaskets between the underside of lid **24** and the top surface of manifold plate **30**, or between edges **34** of manifold plate **30** and interior shoulder **36** of lid **24**. Gasket use discussed in *Bhatti*'s paragraph [0019] confers a different benefit—preventing fluid leaking out of the heat sink—than would be gained from inserting gaskets between the interior surfaces of lid **24**

and edges/top surface of manifold plate **30** (*e.g.*, preventing fluid bypass between the inlet flow path and the outlet flow path).

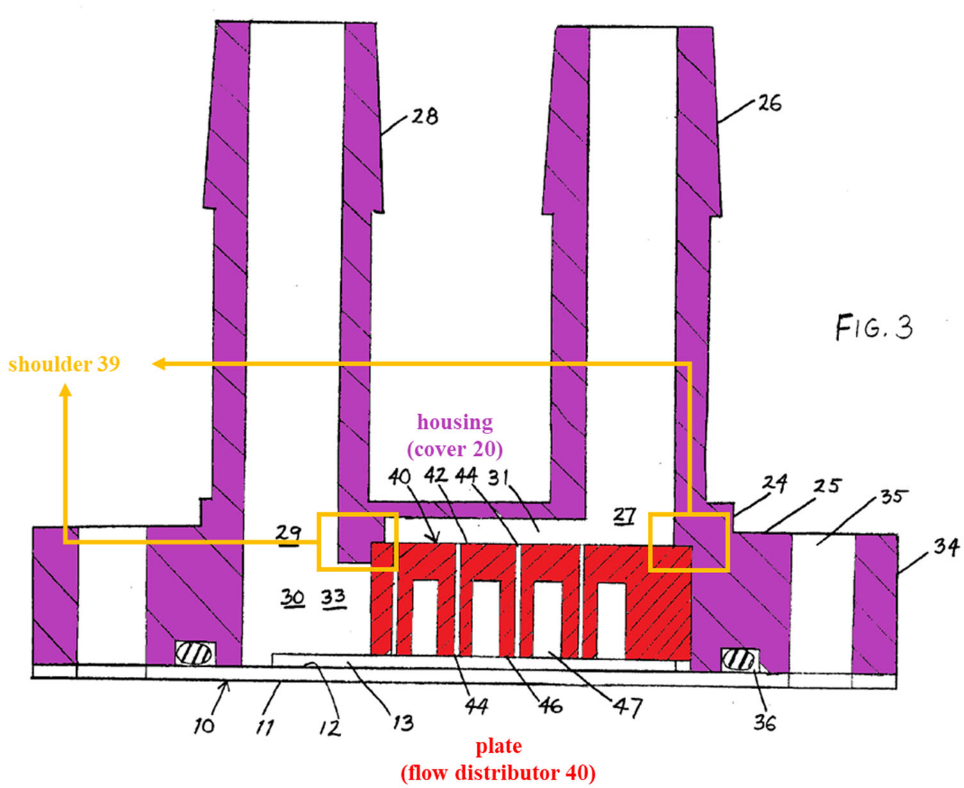
150. Paragraph [0017] discusses the interrelationship between lid **24** and manifold plate **30**; nowhere does it mention gaskets. Instead, it discusses direct contact between these components. (*See* Bhatti, [0017] ("The lid **24** has a periphery engaging the base and an interior shoulder **36** engaging the ends **34** of the manifold plate **30** to define a recessed surface **38** within the periphery and in engagement with the top face of the manifold plate **30**.").) The absence of a gasketing disclosure in paragraph [0017], paired with *Bhatti*'s reference to gaskets for ears **48** in paragraph [0019], would have guided a POSITA's understanding that *Bhatti* did not contemplate inserting gaskets between any surface of manifold plate **30** and lid **24**.

151. Dr. Tuckerman offers no other opinion to support why a POSITA would have been motivated to modify *Bhatti*'s heat sink. For these reasons, it is my opinion that Dr. Tuckerman has not shown that *Bhatti* discloses or renders obvious the "**seal**" limitation in claims 1 and 15.

E. Dr. Tuckerman Fails to Show How the Asserted Claims of the '284 Patent Are Rendered Obvious by *Kang*

1. *Kang* lacks a "housing spaced apart from the plate" (Claims 1, 15)

Dr. Tuckerman identifies *Kang*'s cover **20** ("**housing**") positioned over and spaced apart from flow distributor **40** ("**plate**") "by a shoulder 39." (Tuckerman Op. Rep., Ex. B, Chart III, pp. 7-8, 18.) Like his *Bhatti* analysis, Dr. Tuckerman ignores that shoulder **39** is monolithic with cover **20** and contacts flow distributor **40**:



(Kang, FIG. 3 (annotated).) *Kang* recites how "cover **20** is provided with a first recess **32** and a second recess **38**" where the shoulder **39** is contiguous with cover **20**. (*Id.*, FIG. 3, [0028].) While *Kang* explains that flow distributor **40** is "fixed in the second recess **38** and spaced from the bottom of the second recess by a shoulder **39**," (*id.*, [0028]), nowhere does it suggest that shoulder **39** is separate from the

housing. The abutment of flow distributor **40** to shoulder **39** within cover **20** helps define an inlet section **31** when flow distributor **40** is set within cover **20**, but a POSITA would not have considered an internal cavity defined by portions of cover **20** and flow distributor **40** to satisfy this limitation. This is made clear by the absence of a "**seal**" in *Kang* that fills a gap where the "**housing [is] spaced apart from the plate**," an additional requirement in claims 1 and 15. (*See infra*., Section IX.E.3.)

152. It is thus my opinion that unmodified *Kang* does not anticipate or render obvious this limitation from claims 1 and 15. I cite additional reasons that *Kang* does not anticipate or render these claims obvious in my analysis below.

2. *Kang* does not disclose channel widths with sufficient particularity to enable "microchannels" (Claims 1, 15)

153. Dr. Tuckerman concludes that *Kang* discloses microchannels because it discusses an array of parallel microfins **14**. But microfins are not equivalent to microchannels, and Dr. Tuckerman has not adequately explained how *Kang* teaches or suggests grooves between microfins with channel widths less than a millimeter.

154. Referring to FIGs. 1 and 2, *Kang* explains how its metal cooling plate **10** includes a heat transfer surface **12** that includes an array of parallel microfins **14** upstanding from surface **12**. (Kang, [0028].) These microfins are "formed by rolling grooves into the plate **10**;" *Kang* is silent on the width of these grooves. (*Id*.) A POSITA would not have inferred a width less than 1.0 mm for the grooves simply

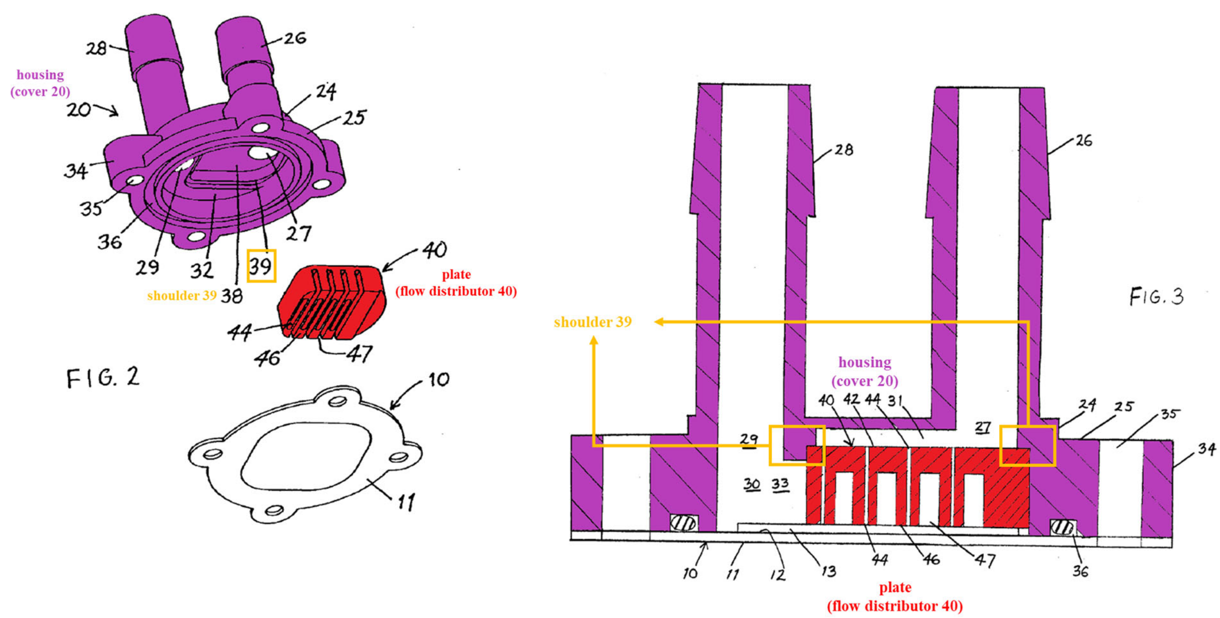
because *Kang* discloses microfins. *Kang* is clear that the prefix "micro" in "microfin" is attributable to fin height rather than width. (*Id.* (noting that microfins **14** "may have a height of as little as 0.001 in. or less.").) It is thus my opinion that *Kang* fails to describe or suggest that grooves formed between microfins would have sufficiently small channel widths to be considered "**microchannels**" per the parties' stipulation.

155. Dr. Tuckerman opines that a POSITA "would have readily recognized that microfins **14** form microchannels between adjacent fins," arguing that "[i]t was well-known in the field of microfluidics in 2007 that microchannels maximize the surface area-to-volume ratio and also provide high flow resistance, which provide better heat transfer efficiency compared to macrochannels or minichannels." (Tuckerman Op. Rep., Ex. B, Chart III, p. 1.) I disagree for the reasons discussed related to modifying *Antarctica*'s channel widths, and I incorporate that analysis from Section VIII.A.1 here in its entirety.

3. ***Kang*'s shoulder 39 is monolithic with cover 20 and not a "seal extending between the housing and the plate" (Claims 1, 15)**

156. Dr. Tuckerman identifies *Kang*'s shoulder **39** as "a component that fills a gap between the housing (cover 20) and the plate (flow distributor 40) to prevent leakage through the gap." (Tuckerman Op. Rep., Ex. B, Chart III, pp. 8, 18-19.) Dr.

Tuckerman's mapping ignores that the claimed "**seal**" must be a "component that fills a gap." *Kang*'s FIGs. 2 and 3 show that shoulder **39** is continuous and monolithic with cover **20**:



(Kang, FIGs. 2, 3 (annotated).) Cover **20** (purple) overlies flow distributor **40** (red) and includes shoulder **39** (in orange boxes). Neither diagram depicts shoulder **39** as a separately identifiable structure from cover **20**.

157. *Kang* confirms that shoulder **39** is part of cover **20** rather than a separate component. With reference to FIG. 2 above, cover **20** "is provided with a first recess **32** and a second recess **38** formed in the bottom of the first recess **32** for receiving a flow distributor **40**." (Kang, [0028].) Flow distributor **40** is received by cover **20** and "fixed in the second recess **38** and spaced from the bottom of the second recess

by a shoulder **39** to form an inlet section **31** of the chamber **30**." (*Id.*; *see also id.*, [0029] (describing how fluid distributor **40** divides inlet section **31** and outlet section **30** of cooling chamber **30**).) A POSITA would have recognized shoulder **39** as a part of cover **20** meant to fix flow distributor **40** into cover **20** and help define the fluid inlet/outlet sections in *Kang*'s heat exchanger.

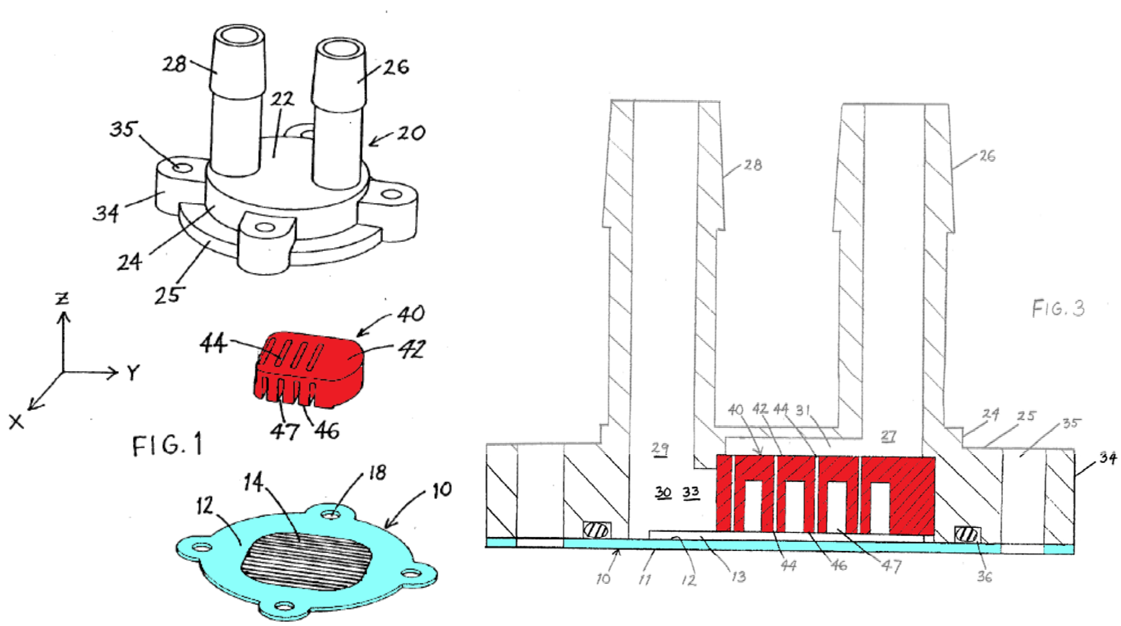
158. Dr. Tuckerman appears to define shoulder **39** as a "**seal**" according to its function, reciting that "[s]houlder 39 prevents fluid bypass between the inlet section 31 and outlet section 33, and forces fluid to enter the elongate inlet opening and flow through the microchannels." (Tuckerman Op. Rep., Ex. B, Chart III, pp. 8, 18.) Even if it serves this "sealing" function, a POSITA would not have understood shoulder **39** to be a "**seal**" under the Court's construction. It is not a component separate from the housing but a part of the housing itself. Accordingly, it is my opinion that *Kang* does not disclose the claimed "seal."

4. ***Kang*'s fluid distributor 40 is not a "plate" (Claims 1, 15)**

159. Dr. Tuckerman maps *Kang*'s flow distributor **40** to the claimed "**plate**," presumably because it has "flat top and bottom surfaces." (Tuckerman Op. Rep., Ex. B, Chart III, pp. 2, 16.) I disagree. A POSITA, and even a lay person, would not have understood an object to be a "**plate**" simply because it has "flat top and bottom surfaces." Many three-dimensional objects have this general characteristic

without being considered a "plate," including cubes, cylinders, and rectangular prisms.

160. Dr. Tuckerman's characterization of flow distributor **40** as a "**plate**" also contradicts *Kang*'s disclosures and admissions from Asetek's expert in IPR2020-00825, Dr. Donald Tilton. In IPR2020-00825, Dr. Tilton testified that "[a] plate is a – generally some kind of flat structure." (COOLIT0033405 (Tilton Depo. Tr. (Dec. 17, 2020), 11:1-8) (underlining added).) Dr. Tilton's testimony is confirmed by *Kang*'s FIGs. 1 and 3, which make clear that flow distributor **40** (red) is not a "flat structure," whereas cooling plate **10** (blue) is:



(Kang, FIGs. 1, 3.) In contrast to flow distributor **40**, *Kang*'s cooling plate **10** is flat and thin.

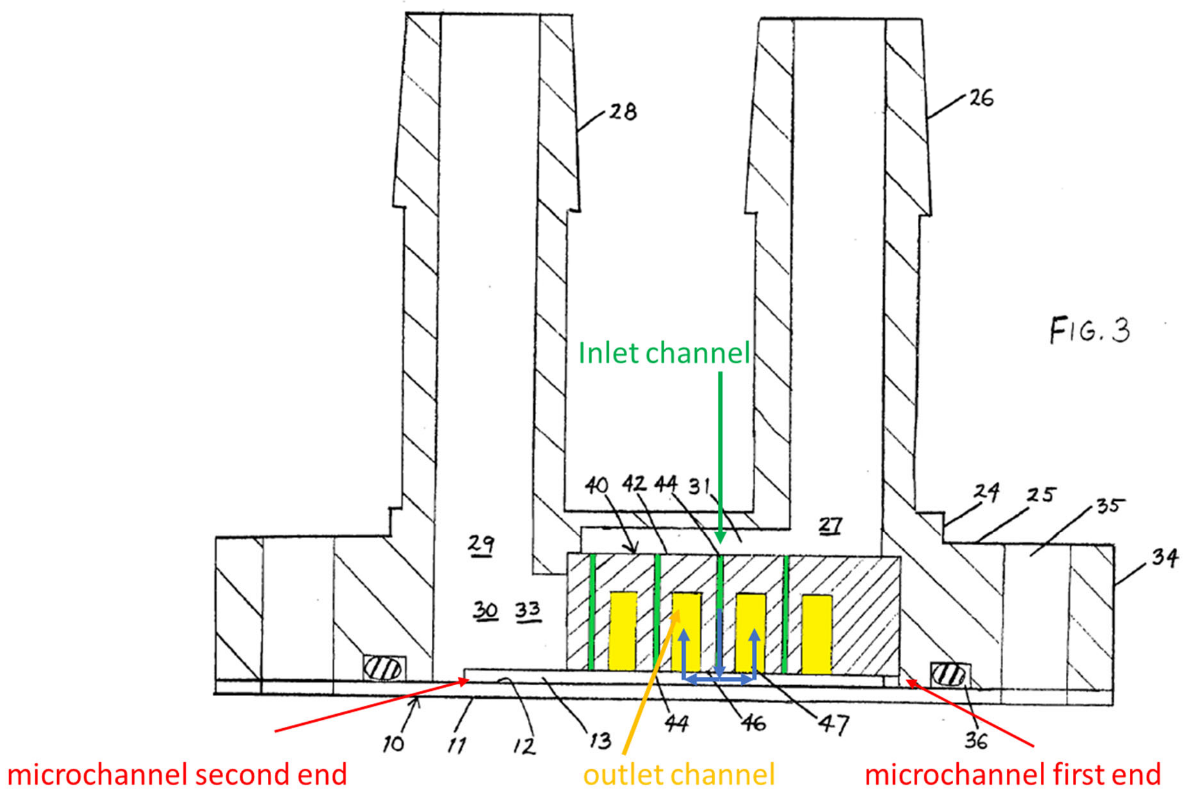
161. Dr. Tuckerman fails to explain why a POSITA would have understood *Kang*'s flow distributor **40** to be a plate when *Kang* distinguishes flow distributor **40** from other thinner, flat structures it describes as plates (*e.g.*, cooling plate **10**). To the extent Dr. Tuckerman's opening report suggests using a "thin" flow distributor **40**, *Kang* specifically teaches away from such a configuration. Such a proposed modification would eliminate channels **47** and render *Kang* inoperable. (*See id*., [0010]-[0016] (citing advantages of *Kang*'s unmodified device).) Accordingly, it is my opinion that *Kang*'s flow distributor **40** does not disclose the "**plate**" recited in claims 1 and 15.

5. *Kang* does not disclose "wherein each respective inlet flow path is split generally into two subflow paths, wherein one of the subflow paths extends outwardly toward the corresponding microchannel first end and passes outwardly of the plate along the outlet flow path from the respective microchannel first end" and a POSITA would have been deterred from eliminating all but one inlet channel and all but two outlet channels in flow distributor 40 (Claims 1, 15[15])

162. Dr. Tuckerman acknowledges that "[f]low distributor 40 of *Kang* creates multiple split-flows throughout the length of each channel." (Tuckerman Op. Rep., Ex. B, Chart III, pp.3, 14.) But *Kang*'s multiple split-flow configuration does not

[15] *Supra,* note 14.

permit a subflow from each inlet flow path to "**pass outwardly… along the outlet flow path from the respective microchannel first end**." As Asetek and its expert in IPR2020-00825 acknowledged, coolant exits through the nearest outlet channel **47** on either side of inlet channels **44**, which may not be at the microchannel first end. (*See* COOLIT0032080-COOLIT0032081, COOLIT0031474-COOLIT0031475.) I have annotated *Kang*'s FIG. 3 to show an exemplary flow path in blue:



(Kang, FIG. 3 (annotated).) Cooling fluid enters inlet section **31** through inlet port **27** and is distributed among several inlet channels **44** (green) defined by flow

distributor **40**. (*Id.*, [0028]-[0029].) Upon exiting from a given inlet channel **44** into gap **48** (not shown in FIG. 3, but understood to be the gap between lands **46** and upper surface **12**), the fluid changes direction and flows along the channel of fin **13** until it reaches a nearby outlet channel **47** (yellow). (*Id.*, [0030].) On reaching outlet channel **47**, fluid within the channel again changes direction, flowing upward (z-direction in *Kang*, FIG. 1) into outlet channel **47**. (*Id.*) Once in the outlet channel **47**, the fluid changes direction (again) and flows laterally (x-direction in *Kang*, FIG. 1) along outlet channel **47** until the flow reaches the edge of the flow distributor **40**, where it exits the outlet channel and enters outlet section **33**. (*Id.*) As shown in the exemplary flow path in annotated FIG. 3 above, both subflows from certain inlet flow paths do not "**pass outwardly… along the outlet flow path from the respective microchannel first end**."

163. To shore up this deficiency, Dr. Tuckerman proposes "simplify[ing] *Kang*'s heat exchanger to have a single split-flow, i.e., to have a single inlet channel 44 midway along the length of the microchannels and two outlets at the ends of the microchannel." (Tuckerman Op. Rep., Ex. B, Chart III, pp. 3, 15.) But Dr. Tuckerman fails to show why a POSITA would have modified *Kang* in this manner, particularly when *Kang* teaches away from using single split-flow in its device.

164. As I described in my analysis on this limitation for *Bhatti*, in fluid heat exchangers, channels with small hydraulic diameters (*e.g.*, microchannels) increase flow resistance as compared to channels with large hydraulic diameters (*e.g.*, macro-channels) and, accordingly, increase pressure drop as a fluid passes along the length of the channel. However, channels with small hydraulic diameters also substantially increase the available surface area for heat transfer as compared to channels with larger hydraulic diameters.

165. *Kang* uses multiple inlets and outlets to generate multiple split-flows, balancing the penalty imposed of increased flow resistance when using channels with small hydraulic diameters with the benefit conferred of increased heat transfer. Specifically, *Kang*'s multiple inlets and outlets provide short flow lengths within the channels, from the point fluid enters the channels (inlet channels **44**) to the point it exits from the channels (outlet channels **47**). (Kang, [0009].) Pressure drop from these short flow lengths is comparatively lower than if fluid traveled along a longer flow path through the channels—*e.g.*, Dr. Tuckerman's proposed single split-flow modification to *Kang*.

166. *Kang*'s multiple split-flow configuration maintains a low overall pressure drop from *Kang*'s inlet section **31** to outlet section **33** as compared to using a longer flow path through the channels, as the various inlets and outlets described above are

fluidly coupled with each other in parallel.[16] At the same time, *Kang*'s device achieves higher overall heat transfer rates from heat transfer surface **12** specifically *because* multiple inlet and outlet channels are able to quickly deliver cool fluid into and out of heat transfer surface **12**.

167. A POSITA, weighing the advantages flowing from *Kang*'s use of multiple inlet channels **44** and outlet channels **47** (*e.g.*, low pressure drop, enhanced heat transfer), would have had no reason to modify *Kang*'s device in the manner Dr. Tuckerman suggests—*i.e.*, eliminating all but a single inlet channel **44** and all but two outlet channels **47**. Reducing flow distributor **40**'s number of outlet channels would likewise reduce the rate that coolant could flow out of *Kang*'s parallel microfin array. Coolant remains in *Kang*'s parallel microfin array under Dr. Tuckerman's proposed modification, causing more fluid preheat and reducing the temperature difference between microfin and coolant. The device's heat transfer rate would significantly decrease because of these modifications. Dr. Tuckerman's proposed modifications also would lengthen coolant flow paths within *Kang*'s parallel microfin array, resulting in a significant increase to flow resistance (*e.g.*,

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[16] Electrical circuitry provides a useful analog, where resistors coupled in parallel reduce a circuit's overall resistance.

higher pressure drop) that would require more pumping power to drive coolant through the array than before.

168. In summary, Dr. Tuckerman's proposed modifications to *Kang* would reduce heat transfer performance, removing the very advantages its inventors sought to achieve in its unmodified, multiple split-flow design. (*See, e.g.*, Kang, [0012] ("cooling fluid is distributed directly to many locations on the surface to be cooled, which minimizes the amount of fluid preheat and maximizes efficiency"); [0013] ("fluid is collected close to the location where it was delivered, which limits the length of the fluid flow path and keeps the pressure drop low"); [0014] ("high heat transfer performance is achieved with low fluid pressure drop").) Accordingly, it is my opinion that a POSITA would have been deterred from implementing Dr. Tuckerman's proposed modifications to *Kang*.

169. I understand that the PTAB in a Final Written Decision affirming the patentability of claims 13-15 of the related '266 patent already rejected the modifications to *Kang* that Dr. Tuckerman proposes in his opening report. I agree with the PTAB's reasoning, reproduced below:

> Petitioner also makes an alternative argument that a POSITA would have been motivated to modify Kang's flow distributor 40 by eliminating all but one inlet channel 44, and all but two outlet channels 47 … Petitioner, however, does not propose to combine Kang with a

second prior art reference that allegedly satisfies the bifurcated flow limitation of claim 13. *See id.* Instead, Petitioner relies solely on the knowledge that a POSITA allegedly would have possessed to supply this missing limitation. *See id.*

In *Arendi S.A.R.L. v. Apple Inc.*, 832 F.3d 1355 (Fed. Cir. 2016), the Federal Circuit noted that "there are at least three caveats to note in applying 'common sense' in an obviousness analysis." *Id.* at 1361. "First, common sense is typically invoked to provide a known motivation to combine, not to supply a missing claim limitation." *Id.* Second, in the only prior case identified by the Arendi parties in which common sense was used to supply a missing claim limitation, "the limitation in question was unusually simple and the technology particularly straightforward." *Id.* at 1362. Thus, that case "ought to be treated as the exception, rather than the rule." *Id.* Third, common sense "cannot be used as a wholesale substitute for reasoned analysis and evidentiary support, especially when dealing with a limitation missing from the prior art reference specified." *Id.*

Here, Petitioner is relying on the common sense knowledge that a POSITA allegedly would have possessed to supply the bifurcated flow limitation of claim 13. Accordingly, this is an unusual situation.

Moreover, the technology at issue is not simple, and it is apparent that multiple modifications to Kang would likely be necessary for success. For example, Dr. Tilton concedes that merely eliminating three inlet channels and two outlet channels would not necessarily yield a

> successful product. Ex. 1003 ¶ 106. These modifications to the inlet and outlet channels would increase flow resistance through the microchannels, possibly requiring further modifications to the microchannels to increase their hydraulic diameters and/or a higher capacity pump (which would be more expensive). Id. In addition, we agree with Dr. Pokharna's well-reasoned opinion that modifying the microchannels to increase their hydraulic diameters would reduce the cooling performance of the modified device. Ex. 2038 ¶ 119. On this record, we determine that technology and proposed modifications are not simple ones of the type that might justify relying on common sense to supply a missing claim limitation.
>
> In addition, the <u>evidentiary support for Petitioner's proposed modification is relatively weak</u>. For example, Dr. Tilton does not provide any explanation or evidentiary support for his assertion that modifying Kang in the manner Petitioner proposes would simplify manufacturing or reduce complexities and costs. See Ex. 1003 ¶¶ 166, 184. This assertion is conclusory and unpersuasive. Petitioner has offered no persuasive rationale supported by evidence or reasoned analysis for why a POSITA would have been motivated to modify Kang in the manner it proposes.

IPR2020-00825 (Paper 50), at 38-39 (underlining added). Similar to Dr. Tilton's analysis in IPR2020-00825, Dr. Tuckerman proposes the same modifications to *Kang*, based on alleged common sense and with little evidentiary support, to arrive

at the limitations in claims 1 and 15 of the '284 patent. And, as the PTAB correctly observed, the technology at issue—generally the same between the '266 and '284 patents—is not simple.

170. In contrast to the rejected motivation to modify from Asetek's expert in IPR2020-00825, Dr. Tuckerman contends that "one skilled in the art would have been motivated to simplify *Kang*'s heat exchanger to have a single split-flow" because "multiple split flows is [*sic*] not needed for simple heat exchangers or when the surface area of the electronic unit to be cooled is not large." (Tuckerman Op. Rep., Ex. B, Chart III, pp. 3, 14.) Yet, Dr. Tuckerman's statements do not disclose any motivation to modify *Kang*, as nothing in *Kang* suggests its design is inappropriate or ill-suited for "simple heat exchangers or when the surface area of the electronic unit to be cooled is not large." *Kang* extends its cited advantages of its device to numerous applications, including varying heat transfer structures and surface area sizes. (*See* Kang, [0010] (underlining added) ("The new distributed flow impingement and collection concept enables high performance cold plates to be formed using <u>a variety of enhanced heat transfer structures</u>. The concept is suitable for both single-phase and two-phase cold plates."); [0011] (applicability with multiple types of heat transfer surfaces and/or heat transfer enhancement structures); [0015] (size of the cooled surfaces "can be easily scaled" without

sacrificing cooling capability per unit surface area); [0016] (applicability with surfaces having non-uniform heat fluxes); [0017].) Moreover, Dr. Tuckerman supplies no countervailing benefit to using a modified *Kang* (*e.g.*, single-pass split-flow design) that would motivate a POSITA to forego the increased heat transfer performance achieved by *Kang*'s unmodified device. It is thus my opinion that Dr. Tuckerman has not provided an adequate, let alone any, reason a POSITA would have been motivated to modify *Kang* in the manner he proposes in his opening report.

F. Dr. Tuckerman Fails to Show How the Asserted Claims of the '284 Patent Are Anticipated or Rendered Obvious by *Hamilton*

1. *Hamilton*'s chip/die 20″ is a heat source and not part of a "fluid heat exchanger" (Claims 1, 15)

171. As I discussed in Section III, the Court construed the term "**fluid heat exchanger**" as a "**component that transfers heat from a heat source to a cooling liquid circulated by a pump that is external to the component**." Implicit in the Court's construction is that a fluid heat exchanger is separate from a heat source it transfers heat from. A POSITA would have understood the distinction between these components, as confirmed by the preamble language of claims 1 and 15: "[a] fluid heat exchanger <u>for cooling an electronic device</u>."

172. Dr. Tuckerman maps the claimed "**plurality of spaced-apart walls…**" to *Hamilton*'s die **20″**. But a POSITA would have understood that die **20″** is the electronic device referred-to in the preamble, and not part of the fluid heat exchanger. *Hamilton* discusses how "[i]n conventionally cooled power semiconductors, … the heat generated in a silicon substrate is conducted through several layers of material to an air or liquid cooled heat sink." (Hamilton, 1:51-54 (underlining added).) *Hamilton* contrasts these prior art methods with its purported invention, asserting that, "[i]n its preferred embodiment, a plurality of microchannels are formed directly in the substrate portion or die of a silicon or silicon carbide chip mounted on a ground plane element of a circuit board and where a liquid coolant is fed to and from the microchannels through the ground plane." (*Id*., 2:9-13 (underlining added); *see also id*., 2:44-52.) *Hamilton* explains that by fabricating microchannels "directly in the active device portions of the chip or die on which a plurality of identical semiconductor devices are fabricated," liquid coolant may be brought "as close as possible to the heat source" to "eliminat[e] the inefficient thermal gradients throughout the device, circuit board, and heat exchanger." (*Id*., 4:49-52.)

173. Dr. Tuckerman's mapping relies on *Hamilton*'s second embodiment for all disclosures except a "**seal**," as depicted in FIGs. 9-12. (*See generally* Tuckerman

Op. Rep., Ex. B, Chart IV.) In particular, he maps the "**plurality of spaced-apart walls**" to chip/die **20″**. *Hamilton* explains that the second embodiment depicts "an implementation for microchannel cooling of a die of power switching semiconductor devices such as insulated gate bipolar transistors." (Hamilton, 6:25-27 (underlining added).) The "semiconductor structure," represented by FIG. 9, comprises "a silicon chip/die **20″** on which is formed a plurality of insulated gate bipolar transistors (IGBT) having a common upper emitter region **72** and underlying common collector region **74** and respective interdigitated gate electrodes **76**." (*Id.*, 6:27-32.) This common collector region **74** is continuous and monolithic with region **78** that contains a plurality of microchannels (*id.*, 6:32-34) to form chip/die **20″**—*i.e.*, the microchannels are part of the semiconductor chip, the heat source. *Hamilton* confirms the microchannels are etched on the heat source rather than a separate fluid heat exchanger, referring to chip/die **20″** as an "IGBT microchannel structure." (*Id.*, 6:38-39.) IGBTs were well-known semiconductor devices in 2007, and a POSITA would have considered IGBTs to be the electronic devices to be cooled by the claimed fluid heat exchanger, not part of the heat exchanger itself.

174. It is therefore my opinion that Dr. Tuckerman improperly maps chip/die **20″** to the claims. This structure is not part of the claimed fluid heat exchanger. It is a part of the heat source.

2. *Hamilton* does not disclose a "housing," let alone a "housing positioned over and spaced apart from the plate" (Claims 1, 15)

175. Dr. Tuckerman argues that "the *Hamilton* heat exchanger includes a housing (ground plane 56′) positioned over and spaced apart from the plate (substrate 24′)." (Tuckerman Op. Rep., Ex. B, Chart IV, pp. 6, 15.) He annotates FIG. 12 as follows to identify the claimed arrangement of plate and housing:

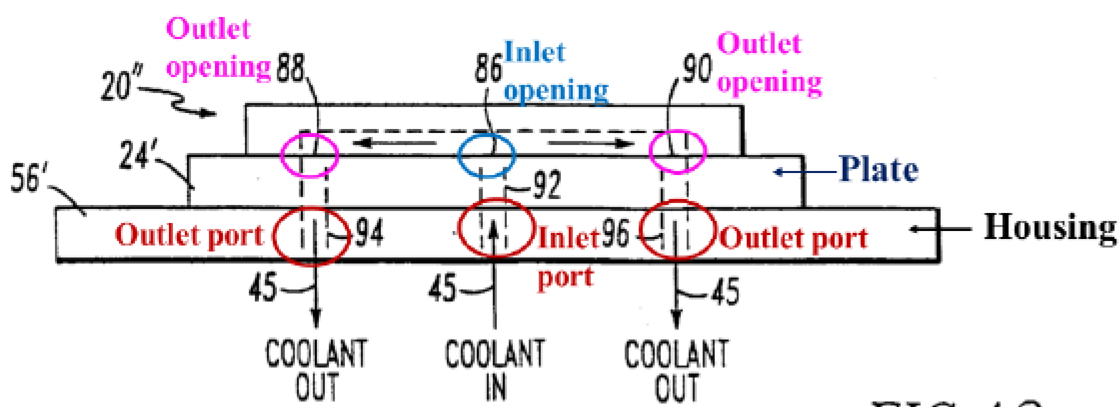


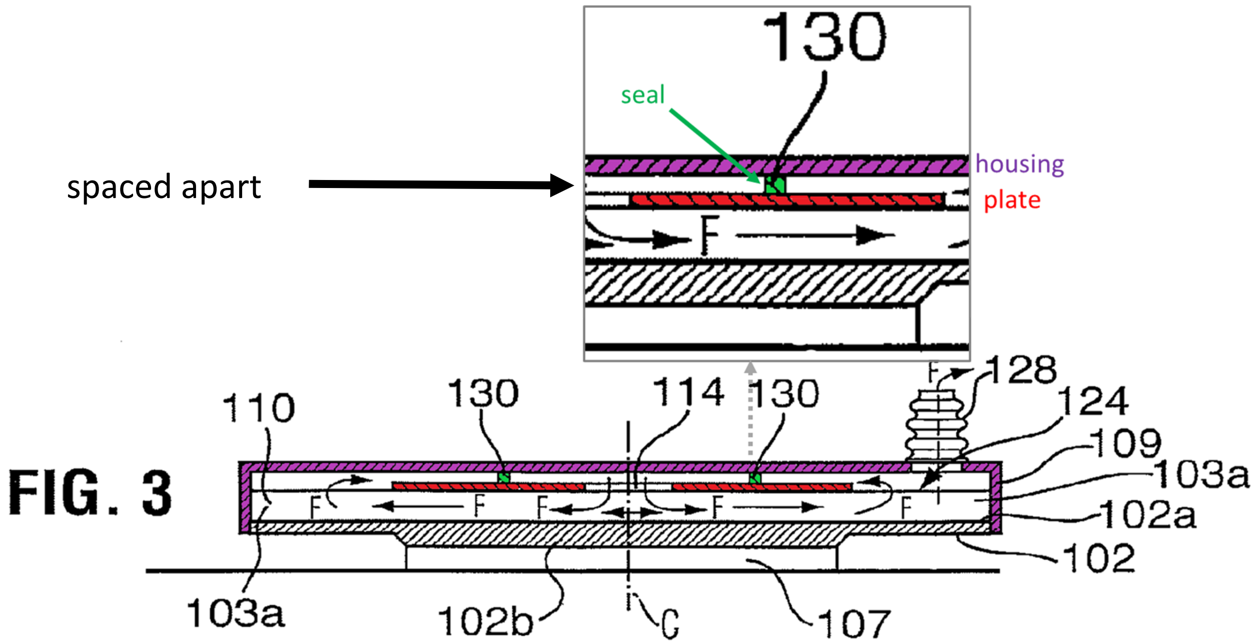
FIG. 12

(*Id.*) However, a ground plane is not a "**housing**." *Hamilton* teaches an invention for cooling semiconductor chips, and a POSITA would have understood that a "ground plane" refers to a large conductive surface or area (often metal) on a printed circuit board that connects a circuit to ground. (Ex. E, *Wiley Electrical and Electronics Eng'g Dictionary* (2004) ("**ground plane**: A sheet, plate or other conductive surface at ground potential which serves as a common reference point for circuit returns and electric potentials. Used, for instance, in circuit boards.").)

This well-understood phrase includes the word "plane"—a flat surface in three-dimensional space—confirming that a ground plane does not enclose anything. Dr. Tuckerman offers only a conclusory mapping and fails to explain why a POSITA would have equated a ground plane to "**housing**."

176. Claims 1 and 15 further require the "**housing**" be "**positioned over … the plate**." However, *Hamilton* teaches how ceramic structure **24′** is "mounted" on ground plane **56′** in a stacked arrangement. (*See* Hamilton, FIG. 12, 6:55-57.) A POSITA interpreting the phrase "**positioned over**" by its plain meaning would have understood the claimed plate to be positioned within a recess of the housing. (*See* '284, FIGs. 1-3, 2:54-60.) Such a configuration is impossible in *Hamilton*'s second embodiment, and Dr. Tuckerman offers no opinions to elucidate how a POSITA would have interpreted "**positioned over**" as capturing a stacked arrangement.

177. Assuming a POSITA considered a ground plane as "**housing**" (it is not), Dr. Tuckerman also fails to show how ceramic substrate **24′** is "**spaced apart**" from ground plane **56′**. These two layers abut and contact each other—*Hamilton* even suggests they are brazed together. (*See* Hamilton, 3:54-58, FIG. 12.) The stacked arrangement of these layers clashes with the '284 patent's disclosures where the claimed plate and housing are spaced apart, in part, by a seal:



('284, FIG. 3 (annotated).) While housing **109** and the plate defining opening **114** (in red) are interconnected through seal **130**, they otherwise do not abut or contact each other. Claims 1 and 15 in the '284 patent reflect this arrangement, with each requiring (1) "**a housing positioned over and spaced apart from the plate**" and (2) that a "**seal extend[s] between the housing and the plate**." Dr. Tuckerman's mapping is manifestly incorrect because it ignores the necessary spatial relationship between the claimed housing and plate.

178. It is therefore my opinion that Dr. Tuckerman has not shown that Hamilton discloses a "**housing positioned over and spaced apart from the plate**," or even a "**housing**."

3. *Hamilton* does not disclose a "seal extending between the housing and the plate and separating the inlet flow path to

each of the microchannels from the outlet flow path from each of the microchannel first ends." (Claims 1, 15)

179. Dr. Tuckerman acknowledges that *Hamilton*'s second embodiment in FIGs. 9-12 lacks a "**seal**." (Tuckerman Op. Rep., Ex. B, Chart IV, pp.7, 15-16.) He opines that, because *Hamilton*'s first embodiment discloses a "pair of O-rings 58 and 60" that act as seals between coolant ducts in a ground plane and input and output ports at the flange of a silicon bipolar transistor, a POSITA would somehow be motivated to insert O-rings between the ceramic structure and ground plane in *Hamilton*'s second embodiment. It is my opinion that Dr. Tuckerman commits classic hindsight to arrive at the "**seal**" limitation and fails to articulate why a POSITA would modify *Hamilton*'s second embodiment in this manner.

180. *Hamilton* provides no express or implied motivation to insert O-rings between the ceramic structure and ground plane in its second embodiment, but teaches away from doing so. *Hamilton* teaches how various substrates within bipolar transistor packages (such as those depicted in FIGs. 4-7 (first embodiment) and FIGs. 8-12 (second embodiment)) "are brazed together in one operation using a gold/copper (Ag/Cu) alloy braze which is then gold (Ag) plated to provide a finalized package." (Hamilton, 3:54-58.) Although this passage discusses prior art packaging techniques, a POSITA would not have understood *Hamilton*'s disclosures with respect to its first and second embodiments to fundamentally alter the fusion

technique used between these layers of a bipolar transistor package. For example, *Hamilton* explains with reference to its first embodiment how substrate member **24′** is contiguous with the top of flange **22′**, suggesting to a POSITA that these layers are brazed together as previously described. (*Id.*, 5:1-3.) *Hamilton*'s second embodiment also recites mounting a ceramic substrate on a ground plane; brazing techniques are well-suited to joining these two types of materials together. (*See id.*, 6:55-58; Ex. F, *Brazing Handbook*, American Welding Society, pp. 411-421 (4th ed. 1991).)

181. A POSITA would have had no reason to forego brazing these two surfaces together to insert an O-ring between ceramic structure **24′** and ground plane **56′**. *Hamilton* is directed towards cooling improvements for densely packaged components (Hamilton, 1:62-65), and it would make little sense to "unpackage" these components to insert a seal. Doing so would increase manufacturing complexity by injecting additional steps into the fabrication and assembly process. Moreover, use of a seal between surfaces that are traditionally brazed together increases the number of fluidic interconnections within the semiconductor device, and thus the risks of leakage. A POSITA would not have sought these disadvantages by modifying *Hamilton* to include a seal in its bipolar transistor package.

182. But even if a POSITA would have been motivated to incorporate the O-rings from *Hamilton*'s first embodiment into its second embodiment, the resulting bipolar transistor package would nevertheless lack a "**seal . . . separating the inlet flow path to each respective microchannel from both corresponding outlet flow paths from the respective microchannel**." Based on *Hamilton*'s teachings in its first embodiment, a POSITA would have placed O-rings at three separate locations:

FIG.8

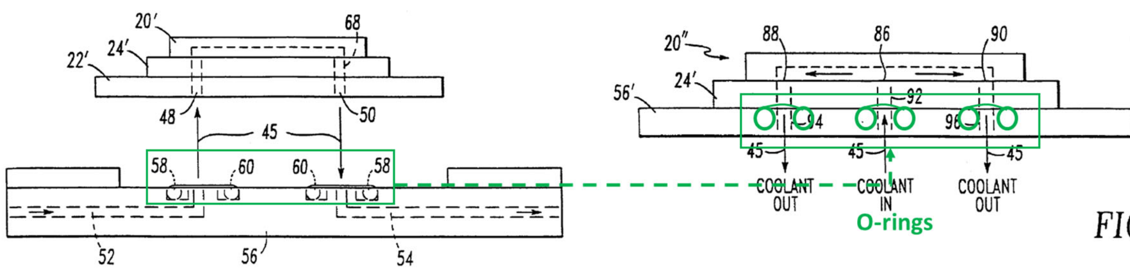


FIG.12

(Hamilton, FIGs. 8 (first embodiment), 12 (second embodiment).) Just as the "pair of O-rings **58** and **60** act as seals for the ducts **52** and **54** coupled to the input and output ports **48** and **50**" in *Hamilton*'s first embodiment, the three O-rings in a modified second embodiment would similarly act as separate seals for (1) coolant input duct **92**, (2) output duct **94**, and (3) output duct **96**. A single seal is not exposed to both an inlet flow path and corresponding outlet flow paths as recited in claims 1 and 15. Moreover, *Hamilton*'s FIG. 12 makes clear that separation of the inlet flow path and corresponding outlet flow paths is incidental to having a seal and occurs

because of the placement of the coolant input/output ducts within the stacked arrangement of and ground plane **56′**, ceramic structure **24′**, and chip/die **20″**.

183. For these reasons, it is my opinion that *Hamilton* fails to disclose or render obvious this limitation.

4. *Hamilton* does not disclose "a spreader plate, wherein the plurality of walls extends upwardly of the spreader plate and the housing contacts the spreader plate" (Claims 4, 19)

184. Dr. Tuckerman maps *Hamilton*'s die **20″** to the claimed "**spreader plate**" and ground plate **56′** to the claimed "**housing**" in his report. For the reasons discussed above in Section IX.F.1, incorporated here in its entirety, chip/die **20″** is not the claimed spreader plate because it is not part of a fluid heat exchanger. But even if chip/die **20″** were part of the claimed fluid heat exchanger, Dr. Tuckerman still has not shown how *Hamilton* discloses or renders obvious claims 4 and 19 (upon which asserted claims 5 and 20 depend).

185. Dr. Tuckerman does not dispute that Hamilton's die **20″** does not touch ground plate **56′**. *Hamilton*'s FIG. 12 shows how these structures are separated by ceramic substrate **24′** and not in contact:

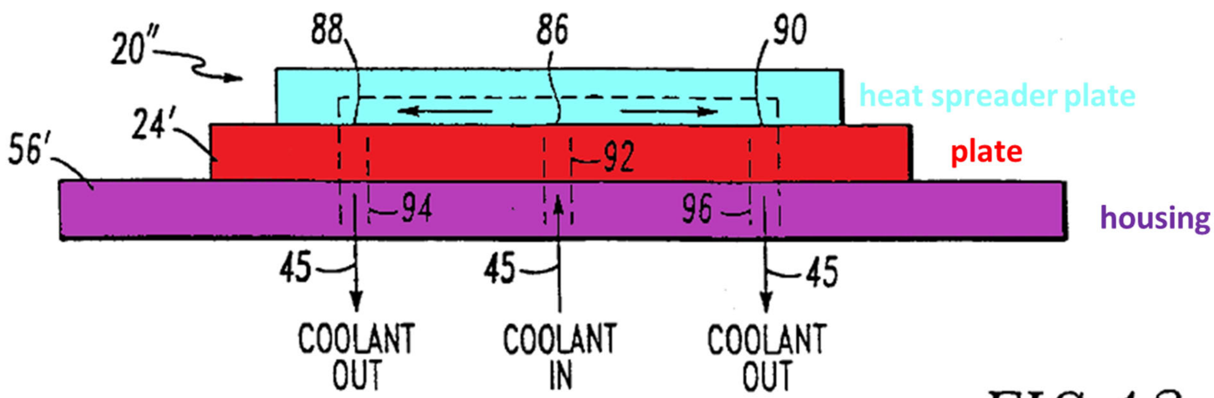


FIG.12

(Hamilton, FIG. 12 (annotated).) Instead, Dr. Tuckerman baldly asserts that "because the housing 56′ and the spreader plate 78 are stacked, the housing 56′ and the spreader plate 78 are indirectly in contact via the plate (substrate 24′)." (Tuckerman Op. Rep., Ex. B, Chart IV, pp. 9, 18.) Critically, he provides no evidence that a POSITA would have interpreted "**contact**" as permitting an intervening structure between the housing and the heat spreader plate—a position that contradicts the word's plain meaning and is simply incorrect. (*See* Ex. G, Oxford College Dictionary (2d ed. 2007) ("**contact**: the state or condition of physically touching."); Ex. H, Merriam Webster's Collegiate Dictionary (11th ed. 2006) ("**contact**: union or junction of two surfaces"); Ex. I, American Heritage Dictionary (4th ed. 2007) ("**contact**: A coming together or touching as of objects or surfaces.").) It is my opinion that a POSITA would have understood from the plain

meaning of "**contact**" that the surfaces of the housing and heat spreader plate must physically touch. *Hamilton* does not disclose this limitation.

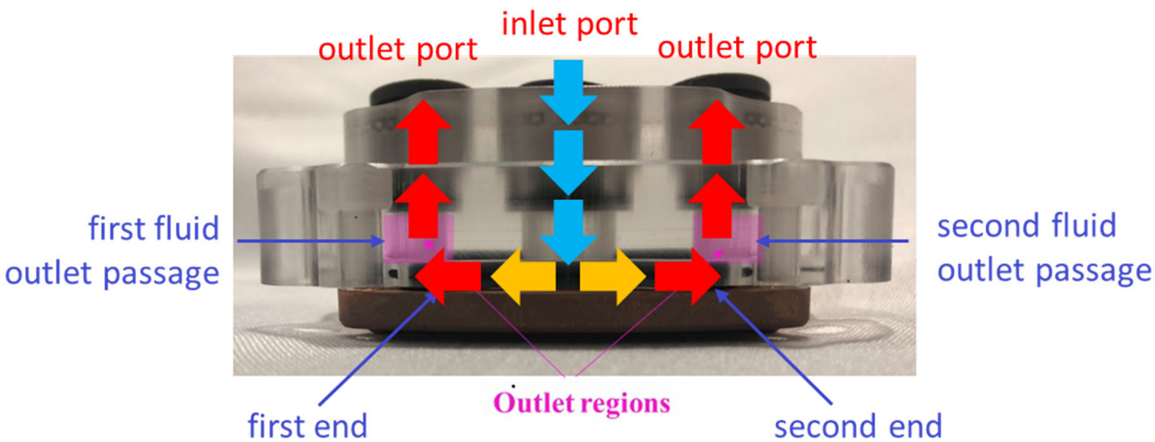
X. OPINIONS REGARDING U.S. 10,274,266

A. *Antarctica*, alone or in view of *Satou*, does not disclose "microchannels" (Claims 13, 15)

186. Claims 13 and 15 of the '266 patent recite the same "**microchannels**" limitation also present in claims 1, 12, and 14 of the '330 patent. *Antarctica* does not disclose this limitation in the asserted claims of the '266 patent for the same reasons I provided in my Section VIII.A analysis above, which I fully incorporate here. Dr. Tuckerman does not rely on *Satou* for disclosing the "**microchannels**" limitation, and in any event, *Satou* is silent on the width of its flow channels. It is therefore my opinion that Dr. Tuckerman has not shown that *Antarctica*, alone or in view of *Satou*, renders obvious claims 13 and 15 of the '266 patent.

B. *Antarctica*, alone or in view of *Satou*, does not disclose "a fluid outlet passage configured to receive the heat exchange fluid from the first end and the second end" (Claim 13)

187. Claim 13 recites a "**fluid outlet passage**" that is "**configured to receive the heat exchange fluid from the first end and the second end**" of a microchannel array. *Antarctica* comprises two separate fluid outlet passages, each consisting of a fluid outlet opening from a single end of a channel array, and an outlet header that opens up through to an outlet region and terminates at an outlet port:

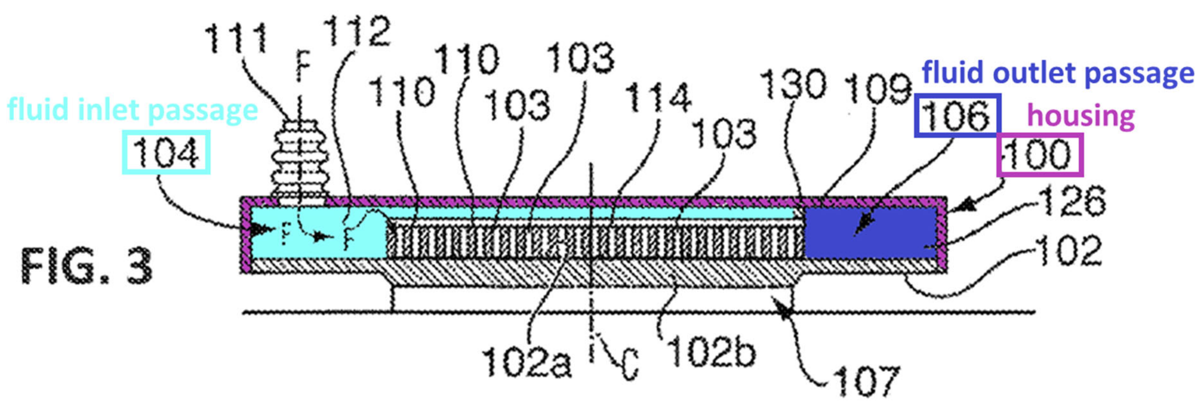


(Tuckerman Op. Rep., Ex. C, p. 6 (annotated).) *Antarctica* fails to satisfy this limitation because each "**fluid outlet passage**" does not "**receive the heat exchange fluid from the first end and the second end**;" it only receives fluid from one end.

188. Dr. Tuckerman attempts to skirt this issue by claiming that the "fluid outlet passage includes a hose to the radiator, a Y-fitting, two outlet ports, and two outlet regions at respective ends of the microchannels." (*Id.*) As an initial matter, I note that Dr. Tuckerman's '266 mapping is internally inconsistent with the general description of *Antarctica* he provides of "a fluid heat exchanger that is connected to a prior art pump, a prior art reservoir, and a prior art radiator in a closed loop using ½ inch and 10 mm hoses." (*See* Tuckerman Op. Rep., ¶55 (underlining added).) This passage confirms that Dr. Tuckerman understands that tubing extending from the Antarctica CPU Cooler is separate from the fluid heat exchanger.

189. Similarly, a POSITA would not have considered Dr. Tuckerman's proposed combination of components to comprise a single "**fluid outlet passage**" that is part of the claimed "**fluid heat exchanger**." The '266 patent describes how its fluid heat exchanger **100** includes a fluid inlet passage **104** and fluid outlet passage **106**, and that a "housing **109** operates with heat spreader plate **102** to form an outer limit of the heat sink and to define fluid flow passages **104**, **106**." ('266, 8:4-9 (underlining added); *see also, e.g., id.*, 9:27-31; 10:33-38, 12:19-22, FIGs. 1-4.) In every disclosed embodiment, the fluid heat exchanger's housing defines the fluid flow passages; they are internal to the housing. FIG. 3 shows an exemplary configuration of fluid inlet and outlet passages relative to the housing within the fluid heat exchanger:

FIG. 3

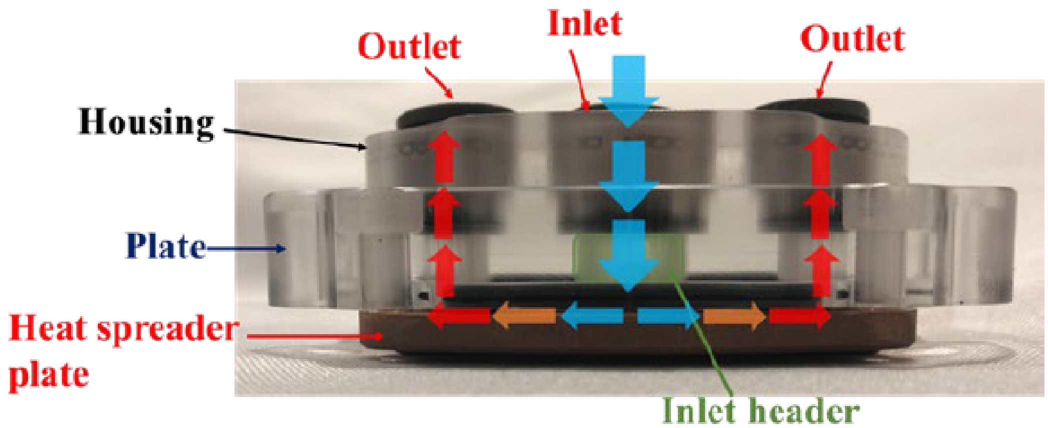


(*Id.*, FIG. 3 (annotated).) Indeed, the specification recites how fluid outlet passage **106** "includes one or more fluid outlet openings **124** from the microporous fluid

channels **103**, a header **126**, and an outlet port **128** opening from the housing." (*Id.*, 10:33-38.)

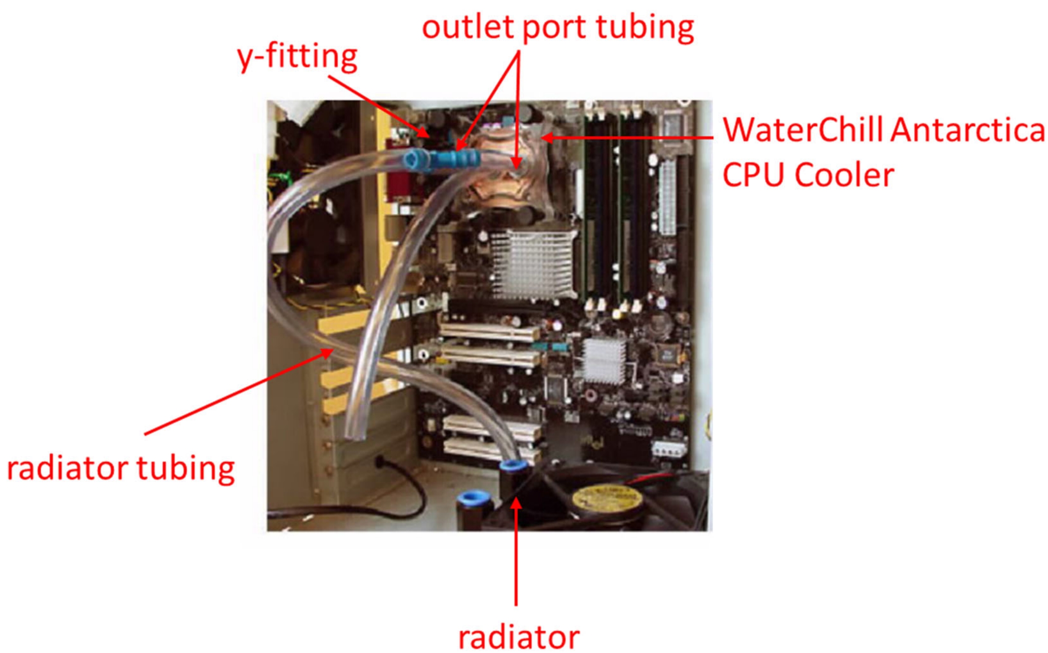
190. Dr. Tuckerman's *Antarctica* mapping for the '330 patent is consistent with this disclosure, acknowledging that the fluid outlet passage discussed in the specification is internal to and defined by the housing.[17] Claim element 1.4 in the '330 patent recites that "the housing defines an inlet and an outlet … wherein the outlet defined by the housing opens from the outlet header." A POSITA would have understood this wherein clause to capture the "fluid outlet passage" discussed in the '266 and '330 specifications. (*Compare, e.g.,* '266, 10:33-38 ("Heat exchanger **100** further includes a fluid outlet passage **106**, which … includes …, a header **126**, and an outlet port **128** opening from the housing."), FIGs. 1-4, *with* '330, 5:1-5 (same), FIGs. 1-4.) Dr. Tuckerman maps *Antarctica* to this claim element by pointing to fluid flow exclusively within the WaterChill Antarctica CPU Cooler unit:

[17] The '330 patent shares the same written description and drawing disclosures with the '266 patent with respect to the above discussion regarding fluid flow passages. (*Compare* '266, FIGs. 1-4, 8:4-9, 10:33-38, *with* '330, FIGs. 1-4, 2:42-48, 5:1-5.)



(Tuckerman Op. Rep., Ex. A, Chart I, p. 5.; *see also id.*, p. 4 ("The outlets defined by the housing open from the outlet headers.").) This mapping makes clear that Dr. Tuckerman understands *Antarctica* to comprise two "fluid outlet passage[s]," wherein one fluid outlet passage captures flow from a first end, and the other fluid outlet passage captures flow from a second end. It is thus my opinion that Dr. Tuckerman's *Antarctica* mapping for the '330 mapping is inconsistent with his mapping for claim 13 of the '266 patent.

191. The tubes from the two outlet ports, the Y-fitting, and the hose to radiator are all separate and distinct components connected and mainly disposed outside of *Antarctica*'s housing. A photograph of an installed WaterChill system confirms that these are separate components:



(ASE-CLT00044717 (annotated).)

192. Supporting materials packaged with *Antarctica* also confirm that a POSITA would not have considered tubing from the outlet ports, the Y-fitting, and the hose to the radiator to be part of the claimed "**fluid heat exchanger**." The *Antarctica* user manual includes a part list and assembly diagrams that show how these components are separate from the *Antarctica* fluid heat exchanger (*i.e.*, "WaterChill Antarctica CPU Cooler"):

Parts list for WaterChill™ Antarctica CPU Cooler

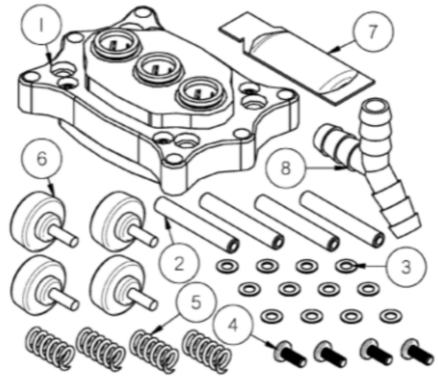


Figure 2

Part No.	Part name	Quantity
1	WaterChill™ Antarctica CPU Cooler	1
2	Guide	4
3	Washer	12
4	Screw	4
5	Spring	4
6	Thumb Screw	4
7	Heat Conduction Compound	1
8	Y – Fitting (The appearance of the actual fitting can differ from the drawing)	1

WaterChill™ Antarctica CPU Cooler 3

Installing the WaterChill™ CPU Cooler

Part numbers refer to parts in Figure 2.

Installation on Intel Socket 478 CPUs

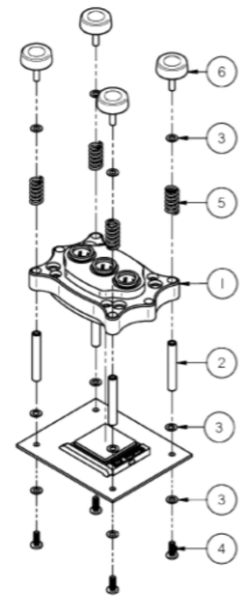


Figure 3

Installation on AMD Socket 462 CPUs

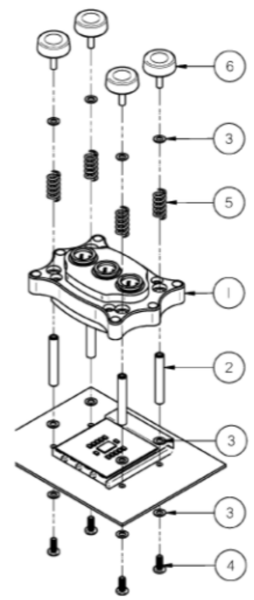


Figure 4

NOTE... *Apply a thin layer of Heat Conduction Compound on the Chip before installing the WaterChill™ CPU Cooler.*

(ASE-CLT00045008, ASE-CLT00045009; *see also* ASE-CLT00045010, ASE-CLT00045012 (showing additional assembly diagrams without mention of tubing or Y-fitting).) Tubing is not included in the part list. And tellingly, both the tubing and Y-fitting are absent from the WaterChill Antarctica CPU Cooler assembly instructions. These components only appear in a section entitled "Connecting the hoses" where the manual specifies that an end user must take a series of manual steps (*e.g.*, cutting hoses, connecting hoses and fittings) to ensure the Antarctica WaterChill CPU Cooler is integrated into the WaterChill liquid cooling system. (*See* ASE-CLT00045011.) A POSITA would have considered these extra components

in a similar manner to the WaterChill system's radiator and pump, that is, external to the fluid heat exchanger.

193. Dr. Tuckerman offers an alternate mapping for this limitation based on *Antarctica* in view of *Satou*. Specifically, Dr. Tuckerman contends that it would have been obvious to eliminate the need for external tubing and a Y-fitting by modifying *Antarctica* consistent with *Satou*'s FIG. 1B "to have an outlet passage structure like that in *Satou* where the flows from the outlet region are combined into a single flow within the *Antarctica* waterblock before exiting to the radiator." (Tuckerman Op. Rep., Ex. C, pp. 7-8.) However, Dr. Tuckerman contends that this would involve a "simple engineering modification… where the flows from the outlet regions are combined into a single area in the heat spreader plate (such as an outlet plenum adjacent the fin array) that leads to a single outlet port (as in *Satou*)." (*Id*., p. 8.) However, it is my opinion that these proposed modifications would render *Antarctica* inoperable for its intended purpose.

194. *Antarctica*'s vertical inlet/outlet port configuration was designed to retrofit on existing motherboards where such cooling devices were not considered in the design cycle. Accordingly, *Antarctica*'s design factored in motherboard keep-outs, accounting for minimal clearance when the device is placed on a CPU / GPU. (*See* ASE-CLT0045006 (describing intended use for "Intel Socket 478, AMD Socket 462

/ 754 / 939 / 940").) The user manual expressly acknowledges this tight-fitting environment when describing a specialized accessory: "As some MotherBoards have MotherBoard components installed inside the keep-out area specified by AMD, and these will conflict with the original WaterChill Antarctica CPU Cooler lid, a special AMD Socket 462 Lid is available for the WaterChill Antarctica CPU Cooler." (ASE-CLT00045012.) Asetek also produced a photograph of an *Antarctica* assembly disposed on a motherboard, where it is apparent how little clearance is available beyond the fluid heat exchanger:

(ASE-CLT00044713.) The unmodified *Antarctica* configuration lacks a recombination chamber and orients inlet/outlet ports and tubing vertically to permit a modular design where an end-user could snap the heat exchanger on to different CPU sockets and into different motherboard builds. *Antarctica*'s modular design is a core benefit to DIY enthusiasts that this product targets. A POSITA would have

thus been discouraged from modifying *Antarctica* in a manner that expands the design dimensions and conflicts with motherboard keep-outs.

195. Dr. Tuckerman's proposed modifications would necessarily require a heat spreader plate with a larger surface area to accommodate an outlet plenum that is adjacent to the channel array. In other words, the addition of an outlet plenum to the heat spreader plate would increase device clearance. I further note that *Satou* FIG. 1B includes a single outlet port oriented on a plane perpendicular to the inlet port. Modifying *Antarctica* to shift the outlet port from a vertical to a horizontal opening would further increase device clearance to permit radiator tubing to be connected to the outlet port. Contrary to Dr. Tuckerman's conclusory assertion that the proposed modifications "make[] installation of the system easier for the user," the increased device clearance would prevent users from mounting the heat exchanger onto a CPU within numerous motherboard builds. And tellingly, Dr. Tuckerman recognizes that increased clearance is highly undesirable within fluid heat exchangers, as he recites that a POSITA would have sought an improvement that "(3) creates a small and compact solution that is easy to implement; and (4) saves space inside computer—the saved spaced could be used for additional CPUs/GPUs or other components." (*See* Tuckerman Op. Rep., ¶145.) It is unclear to me why Dr. Tuckerman proposes a modification to *Antarctica* in view of *Satou* that is inconsistent with the very design

objectives for fluid heat exchangers (such as AIO coolers) that he discusses later on in his report.

196. At the very least, such modifications would either complicate installation or limit *Antarctica*'s compatibility with various CPU sockets and/or motherboard builds. Both outcomes would have been highly undesirable to DIY enthusiasts—*Antarctica*'s target market—who value modularity and interchangeability in computer component. Accordingly, it is my opinion *Antarctica* teaches away from *Satou*'s FIG. 1B configuration, and a POSITA would not have been motivated to make Dr. Tuckerman's proposed modifications.

197. Finally, Dr. Tuckerman suggests that a POSITA would "have had a reasonable expectation of success" in making the proposed modifications by pointing to a flow path diagram (Figure 12) in the user manual. (Tuckerman Op. Rep., Ex. C, pp. 8-9.) The user manual provides no written explanation for Figure 12, and Dr. Tuckerman presents no evidence that Asetek released a commercial version of *Antarctica* that included a single outlet port. Rather, Figure 12 provides a top-down view of a "CPU" where the expected location for the second outlet port is obscured by tubing connecting the "CPU" to the "Chipset" unit. A POSITA would have reconciled Figure 12's ambiguity by referring to the rest of the manual, which discusses a waterblock with two outlet ports and connecting tubing from these outlet

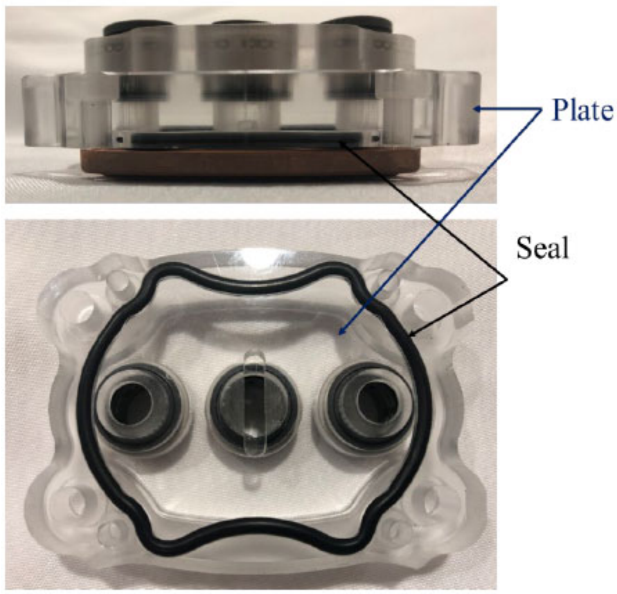
ports to a Y-fitting. It would be unlikely that a POSITA would have inferred a reasonable expectation of success from this diagram given that all other disclosures, including the product itself, are silent as to the feasibility of a single outlet port.

C. A POSITA would not have made Dr. Tuckerman's proposed modifications to *Antarctica* described in his alternate mapping for "seal" (Claim 13)

198. Claim 13 of the '266 Patent recites the same "**seal**" limitation also present in claims 1, 12, and 14 of the '330 Patent, with an additional caveat that "**the seal is a portion of the plate**." Similarly, Dr. Tuckerman provides an alternate mapping for "seal" that mirrors his analysis of the same limitation for the '330 Patent. (*See* Tuckerman Op. Rep., Ex. C, pp. 2-3.) His alternate mapping of a "**seal**" for *Antarctica* does not disclose or render obvious this limitation in claim 13 for at least the same reasons I provided in my Section VIII.A.4 analysis above, which I fully incorporate here. Dr. Tuckerman's alternate mapping is further deficient because it fails to explain how or why a POSITA would have modified *Antarctica* such that the proposed O-ring was a "**portion of the plate**" as opposed to a separate component or portion of the housing.

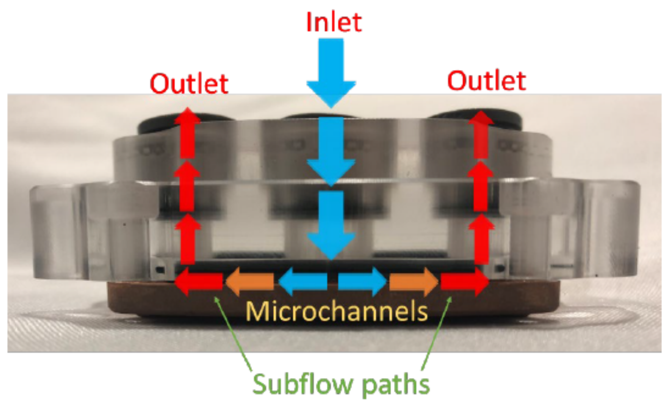
D. *Antarctica*, alone or in view of *Satou*, does not disclose "wherein the seal separates the fluid inlet passage from the fluid outlet passage" (Claim 13)

199. To start, Dr. Tuckerman relies only on *Antarctica* in his mapping for this limitation. Nowhere does he cite or rely on *Satou*. Dr. Tuckerman first maps the claimed "**seal**" in his analysis of claim 13 to the seal inlaid in *Antarctica*'s monolithic and continuous structure:



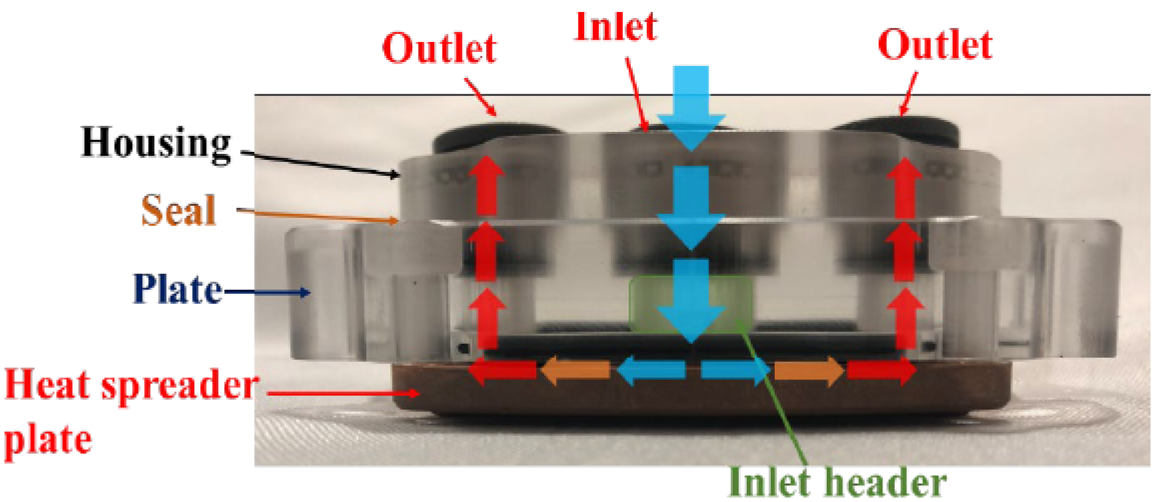
(Tuckerman Op. Rep., Ex. C, p. 2.) This seal surrounds the inlet port and two outlet ports extending through *Antarctica*'s housing. However, *Antarctica*'s housing-seal configuration constrains the seal's function to preventing leakage of fluid between the housing and heat spreader plate. The seal does not separate the inlet port/passage from the outlet port/passage as recited in claim 13.

200. Dr. Tuckerman's own annotations highlight the deficiency in his mapping:



(Tuckerman Op. Rep., Ex. C, p. 10.) *Antarctica*'s side profile shows how fluid flows into the inlet passage, bifurcates within the heat spreader plate channel array, and then flows via two fluid outlet passages—surrounded, rather than separated, by Dr. Tuckerman's mapped "**seal**." Indeed, it is *Antarctica*'s continuous and monolithic structure, not the inlaid seal, that provides the requisite separation between the inlet and outlet passages.

201. Dr. Tuckerman's alternate mapping for "**seal**"—which I disagree with for the reasons stated in Section VIII.A.4—fails to cure this deficiency. Were an O-ring sandwiched between a structurally distinct housing and plate in a modified *Antarctica*, it is the plate, not the O-ring, that separates the fluid inlet passage from the fluid outlet passage. Dr. Tuckerman annotated the side profile picture of *Antarctica* to show his proposed placement for an O-ring:



(Tuckerman Op. Rep., Ex. A, Chart I, p. 9.) The O-ring plays no functional role in separating the fluid inlet passage from the fluid outlet passage. Separation occurs because of (1) the relative placements of the inlet and outlet ports in the "plate" and (2) the fact that the "plate" is sandwiched against the heat spreader plate.

202. For these reasons, it is my opinion that *Antarctica*, with or without Dr. Tuckerman's proposed modifications for a "**seal**," fails to disclose or render obvious "**wherein the seal separates the fluid inlet passage from the fluid outlet passage**."

E. *Antarctica*, alone or in view of *Satou*, does not disclose "wherein the two sub flows recombine in the outlet passage." (Claim 13)

203. As described in my analysis for Section X.B, fully incorporated here, *Antarctica* lacks a fluid outlet passage that receives heat exchange fluid from both the first and second end of a microchannel array, and a POSITA would not have

modified *Antarctica* in view of *Satou* to include an outlet plenum and single outlet port. Rather, *Antarctica* comprises two fluid outlet passages extending from a channel opening to an outlet port. Each fluid outlet passage receives one subflow.

204. Dr. Tuckerman admits that the two subflows—one per fluid outlet passage—remain separate before exiting *Antarctica*'s outlet ports. (*See* Tuckerman Op. Rep., Ex. C, p. 6 ("Although the *Antarctica* has two outlet ports, cooling fluid from the two outlet ports are combined into one flow using a Y-fitting after exiting the ports"); *see also* ASE-CLT00045011.) Subflow recombination occurs outside the *Antarctica* fluid heat exchanger, as shown below:

(ASE-CLT00044713.) The two sub-flows only combine when their respective outlet port tubes connect to an external Y-fitting. Accordingly, it is my opinion that